

B. SCUP

TERMS OF REFERENCE

1. Characterize the commercial and recreational catch including landings and discards.
2. Estimate fishing mortality, spawning stock biomass, and total stock biomass for the current year and characterize the uncertainty of those estimates.
3. Evaluate and either update or re-estimate biological reference points as appropriate.
4. Where appropriate, estimate a TAC and/or TAL based on stock status and target mortality rate for the year following the terminal assessment year.
5. If stock projections are possible, provide short term projections (2-3 years) of stock status under various TAC/F strategies and evaluate current and projected stock status against existing rebuilding or recovery schedules, as appropriate.

INTRODUCTION

Scup, *Stenotomus chrysops*, are a schooling, continental shelf species of the Northwest Atlantic, distributed primarily between Cape Cod, MA and Cape Hatteras, NC (Morse 1978). Scup undertake extensive migrations between coastal waters in summer and offshore waters in winter. Scup migrate north and inshore to spawn in spring. Larger scup (0.7-1.8 kg) tend to arrive in spring first, followed by smaller scup (Neville and Talbot 1964; Sisson 1974). Larger scup are found during summer near the mouth of larger bays and in the ocean within the 20-fathom contour; smaller scup are found in shallow areas of bays (Morse 1978). Scup migrate south and offshore in autumn as the water temperature decreases, arriving in offshore wintering areas by December (Hamer 1970; Morse 1978).

Spawning occurs from May through August and peaks in June. About 50% of age-2 scup are sexually mature (about 17 cm total length; NEFSC 1993). Scup can attain a maximum length of about 40 cm and a maximum age of about 20 years (Dery and Rearden 1979). Crecco *et al.* (1981) have characterized scup as slow-growing and relatively long-lived fish.

Tagging studies (e.g., Neville and Talbot 1964; Cogswell 1960, 1961; Hamer 1970, 1979) have indicated the possibility of two stocks of scup, one in Southern New England and another extending south from New Jersey. However, a lack of definitive tag return data coupled with distributional data from the NEFSC bottom trawl surveys support the concept of a single unit stock extending from Cape Hatteras north to New England (Mayo 1982).

The Mid-Atlantic Fishery Management Council (MAFMC) and the Atlantic States Marine Fisheries Commission (ASMFC) manage scup under Amendment 8 to the Summer Flounder, Scup, and Black Sea Bass Fishery Management Plan (FMP). The FMP defines the management unit as scup in US waters from Cape Hatteras northward to the US-Canadian border. Exploitation rates were to be reduced to 47% ($F=0.72$) in 1997-1999, to 33% ($F=0.45$) in 2000-2001, and to 21% ($F=0.26$) in 2002 through coast-wide commercial quotas and recreational season, size and possession limits that are established on an annual basis. Amendment 12 to the FMP established a biomass threshold for scup based on the maximum value of the 3-year moving average of the NEFSC spring bottom trawl survey index of spawning stock biomass - 2.77 kg per tow, 1977-1979. The scup stock is overfished when the spawning stock biomass index falls below this value. Amendment 12 defined overfishing for scup to occur when the fishing mortality rate exceeds the threshold fishing mortality of $F_{\max}=0.26$.

The Total Allowable Catch (TAC) of 9.11 million lbs (4,132 mt) established in 1997 included a commercial fishery quota of 6.00 million lbs (2,722 mt), a recreational fishery harvest limit of 1.95 million lbs (885 mt), and projected total discards of 1.16 million lbs (528 mt). The TAC decreased steadily to a low of 5.92 million lbs in 1999 and 2000 followed by a significant increase in 2001 to 8.37 million lbs (3797 mt). The 2002 TAC increased further to 12.92 million lbs with a commercial quota of 8 million lbs (3629 mt), a recreational harvest limit of 2.77 million lbs (1257 mt) and projected total discards of 2.15 million pounds (975 mt).

For 2002, the Board and Council implemented minimum mesh size regulations that vary according to net size. Large nets may have up to 25 meshes of 4.5@ in the codend, with at least 100 meshes of 5@ forward of the 4.5@ mesh. Small nets, defined as those with codends smaller than 125 meshes including extension, must have 4.5@ mesh throughout. Vessels using nets with smaller mesh may possess 500 lbs. of scup from November through April and 100 lbs. from May through October. The minimum size for scup caught by any net in the commercial fishery remains at 9@.

The ASMFC Summer Flounder, Scup, and Black Sea Bass Management Board approved Addenda V and VII on February 21, 2002 to more effectively manage the scup fishery. Addendum V was enacted to set state-by-state summer period allocations for the summer period scup fishery during 2002 and until action is taken to modify them. The quota was reallocated using 1983-1992 as the base period with updated landings data from Massachusetts.

Addendum VII was implemented to create a state-by-state conservation equivalency system for the 2002 scup recreational fishery. Under this addendum, each state from North Carolina through New Jersey (inclusive) was assigned size, bag and season regulations, while those states from Massachusetts through New York (inclusive) were required to modify their fishing effort based on the performance of their regulations in previous years. Calculations of the state specific effort necessary to achieve the 2002 harvest limit were based on the average number of fish landed from 1998-2000. The addendum also permitted individual states to separate the management of the Party and Charter Boat sector from the remainder of the recreational fishery, provided that the estimated landings for each mode had a percent standard error not greater than 30%.

THE FISHERY

Commercial Landings

US commercial landings averaged over 18,000 mt per year from 1950 to 1966 (peaking at over 22,000 mt in 1960) and declined to about 4,000 mt per year in the early 1970s (Figure B1). Landings fluctuated between 7,000 and 10,000 mt from 1974 to 1986 and have since declined to less than 2,000 mt. Landings in 2001 were 1,729 mt (3.8 million pounds) - less than 8% of the 48.5 million pound peak observed in 1960 (Table B1).

Dealers reported commercial landings in 1994-2001 by market category and not by area of catch. Procedures developed by Wigley *et al.* (1997) were used to allocate landings by market category to statistical area, based on information collected under the Vessel Trip Report (VTR) system. A monthly set of landings, which are reported in both dealer and VTR databases, are used to characterize the distribution of dealer-reported landings by statistical area. This prorating procedure contributes to uncertainty in the attribution of market category landings by area, especially if vessels that are not participating in any fishery with mandatory VTR requirements land scup from different areas than those that produce landings for participating vessels. Other sources of uncertainty include unreported landings by dealers.

About two-thirds of the commercial landings of scup for the period 1979-2001 were in Rhode Island (37%) and New Jersey (28%) (Table B2). Landings in New York composed an average of 15% of the total. Scup landings reported for Massachusetts were revised for the 31st SARC assessment for 1986-1996, increasing an average of 92% or 218 mt per year (range, 182 to 268 mt and 40 to 216%) (NEFSC 2000). MADMF staff obtained affidavits from several major scup dealers detailing previously unreported landings of scup in Massachusetts for the years 1986-1997. Most of this increase was from previously unreported landings in the hand-line gear category, generally employed from vessels of displacement less than 5 gross registered tons. These records are now included in the NMFS NER dealer landings database.

The otter trawl is the principal commercial fishing gear, accounting for an average of 74% of the total catch in 1979-2001 (Table B3). The remainder of the commercial landings is taken by floating trap (12%) and hand lines (6%), with paired trawl, pound nets, and pots and traps each contributing 2-3%.

The intensity of NER commercial fishery biological sampling in 1979-2001 is summarized in Table B4. Annual sampling intensity varied from 25-640 mt per 100 lengths. Overall sampling exceeded the informal criterion of 100 lengths sampled per 200 mt in 17 of the last 23 years. However, this alone does not indicate adequate sampling because many of these strata have substantial landings but lack samples. Commercial landings at age were not estimated for 1998-2001 because an analytical assessment was determined to be unreliable by SAW 27 (NEFSC 1998) due to concerns about commercial landings sampling and estimation of commercial discards in recent years. Estimation of commercial landings at length using the available sample data indicated that most fish in the 1997-2001 commercial landings were age-3 fish of their respective year classes (Figures B2, B3).

Commercial Discards

Estimates

The NEFSC sea sampling program has collected information on landings and discards in the commercial fishery for 1989-2001. NEFSC discard estimates were raised to account for North Carolina landings. A discard mortality rate of 100% was assumed because there are no published estimates of scup discard mortality rates. This assumption is based on limited observations and is a point of some contention between scientists and fishermen. Past SAW panels have recommended that research be conducted to better characterize the mortality of scup in different gear types in order to more accurately assess discard mortality (NEFSC 1995, 1997, 1998, 2000). The number of trips in which scup were landed and/or discarded is tabulated in Table B5. The NEFSC sea sampling program sampled from 7 to 91 otter trawl trips per year in which scup were landed or discarded. The number of sampled trips was especially low in 1994 and 1995 when only 7 and 18 otter trawl trips were sampled. Sample size in 2000 (72 trips) was the largest since 1992, but the number dropped to 28 sampled trips in 2001 (Table B5).

Quantifying discards from the commercial fishery is necessary for a reliable stock assessment, but low sample sizes have resulted in questionable estimates. Concern regarding the poorly estimated discards due to inadequate sampling has been addressed in at least four previous SAW meetings (NEFSC 1995, 1997, 1998, 2000). Members of these previous SARC panels commented that the uncertainty associated with the discards prevents reliable estimates of discard at age in the commercial fishery and seriously impedes the development of a reliable analytic assessment as well as forecasts of catch and stock biomass for the stock. Previous SAW panels have given recommendations for significant improvement in the precision of discard estimates. The most recent SARC that evaluated scup was especially concerned and did not consider an analytical assessment due to uncertainties in the input data, especially discard estimates (NEFSC 2000). Despite the uncertainty of the discard data, the SAW 31 panel concluded that the limited available information suggested that discarding of scup has been high throughout the time series (1989-1999), approaching or exceeding landings. The panel stated that continued unreliability in discard estimates would prevent the use of VPA and production models for producing a reliable assessment.

Given the difficulty associated with estimating commercial discards for scup, the subcommittee considered three different approaches for calculating estimates:

1. Geometric Mean Discards-to-Landings Ratio (GMDL): In previous assessments (e.g., SAW 25 (NEFSC 1997)), ratios of discards to landings by landings level (for trip landings < 300 kg (661 lbs) or => 300 kg) and half year were calculated (uncorrected geometric mean by cell) and multiplied by corresponding observed landings levels from the weigh-out database to provide estimates of discards for use as guidance in setting TAC levels for management (Table B6). Only trips with both non-zero landings and discards could be used. Geometric mean rates (retransformed, mean ln-transformed D/L per trip) were used because the distributions of landings and discards and the ratio of discards to landings on a per-trip basis in the scup fishery are highly variable and positively skewed. N is the number of sea sample trips with both scup landings and discard, which were used to calculate the per trip discard to

landings ratios. Corresponding dealer landings are from the NEFSC database.

The number of trawl gear trips used to calculate geometric mean discard-to-landings ratios (GMDL) by half year for 1997-2001 ranged from 1 to 17 for trips < 300 kg and from 1 to 4 for trips => 300 kg (Table B6). No trawl gear trips were available for half year two in 1997 and 1999 for trips < 300 kg and for half year two in 1997-2001 for trips => 300 kg. The GMDL calculated for half year one was used to estimate discards for half year two when no trawl gear trips were available in half year two. The GMDL ratios ranged from 0.46 in 2001 (half year two, trips < 300 kg) to 121.71 in 1998 (half year one, trips => 300 kg). The large 1998 estimate was based on one trawl gear trip. About 93% of the discard from that trip was attributable to a single tow in which an estimated 68.2 mt (150,000 lbs.) of scup were captured. This tow was not lifted from the water and the captain from the vessel estimated the weight. There has been debate concerning the validity of the tow weight estimate and whether or not it is representative of other vessels in the fishery. However, the observation was reported and was therefore included in the calculation of the GMDL. Estimates for 2001 were relatively low B 0.89 for half year one and 0.46 for half year two for trips < 300 kg (the latter of these was based on only two trawl gear trips) and 0.92 for half year one for trips => 300 kg.

2. **Aggregate Discards-to-Landings Ratio (AGDL):** The second approach for estimating discards considered aggregate discards to landings ratios (summed D/summed L for all trips in stratum). As in the GMDL method, trips are stratified by half-year period (HY1, HY2) and trip landings level (< 300 kg, => 300 kg). N is number of sea sample trips in the stratum used to calculate the aggregate ratio (Table B7). The number of trawl gear trips used to calculate AGDL by half year for 1997-2001 ranged from 14 to 37 for trips < 300 kg and from 1 to 4 for trips => 300 kg. There are more trips available for calculation for trips < 300 kg than in the GMDL approach. The lowest AGDL ratio calculated was 0.69 in 2000(half year one, trips => 300 kg). The largest AGDL was 121.71 in 1998 (half year one, trips => 300 kg) B the same as that calculated in the GMDL method.
3. **Mean Differences between Landings and Discards (DELTA):** Mean differences (kg) between landings and discard ($D = \text{landings} - \text{discard}$, per trip) were also calculated using the same strata as the previous methods - stratified by half-year period (HY1, HY2) and trip landings level (< 300 kg, => 300 kg). N is number of sea sample trips in the stratum used to calculate the mean difference in stratum, which was then applied to the landings of every trip in the NEFSC dealer database to calculate a discard for each trip ($\text{discard} = \text{landings} - (D)$). Calculating differences allows use of trips that had discards but no landings, whereas D/L ratios cannot be calculated in these situations (i.e. zero in the denominator). When discards exceed landings, DELTA values will be negative. As the magnitude of discards is of primary interest, the absolute values will be considered.

The number of trawl gear trips used in the DELTA method calculations ranged from 6 to 37 for trips < 300 kg and from 1 to 4 for trips => 300 kg (Table B8). The magnitude of the DELTA

values ranged from 10.7 in 2001 (half year two, trips < 300 kg) to 72707 in 1998 (half year one, trips => 300 kg). As before, this large discarding event is the result of one large discarding event that was discussed above.

Comparison of Methods

A summary of landings, discards, and aggregate discards to landings ratios from the three alternative methods of discard calculation are presented in Table B9. The year-to-year trends among the different approaches differed in magnitude but followed similar trends. D/L ratios in 1997 and 2001 were relatively low for all methods within each series. The large discard event in 1998 affected calculations from each method, resulting in relatively high D/L values in 1998 for each approach. The DELTA method yielded estimates that were fairly consistent with the GMDL ratios, while the AGDL estimates exhibited more variability. The working group felt most confident in the estimates produced using the GMDL approach and felt the estimates were supported by the DELTA ratios. The GMDL estimates were used for all modeling approached considered.

Estimates of GMDL from sea sampling were compared to estimates from vessel trip reports (VTR) for 1994-2001 (Table B10). VTR data were selected to include only trawl trips that reported some discard of any species. In contrast to black sea bass and New England groundfish discard data, GM D/L for scup for 1994-2001 sea sample data were 2 to 44 times greater than GM D/L for VTR data, with a single exception in 1996 for trips landing => 300 kg.

Length-frequency

The intensity of length frequency sampling of discarded scup from the sea sampling declined in 1992-1995 relative to 1989-1991 (Table B5). Sampling intensity ranged from 496 to 334 mt/100 lengths sampled in 1992-1995, failing to meet the informal criterion of 200 mt/100 lengths sampled. Sampling intensity improved to 100 mt/100 lengths in 1996, but then declined to about 240 mt/100 lengths in 1997 and 1999 and 1,071 mt/100 lengths in 1998. In 2000, sampling intensity dramatically improved to 50 mt/100 lengths. Mean weight was estimated from length frequency data and a length-weight equation, total numbers were estimated by dividing total weight by mean weight, and numbers at length were then calculated from the length-frequency distribution. Discards were dominated by fish aged 0, 1, or 2, depending on the year under consideration. There is some evidence for discarding of a strong 1994 year class based on the changes in length and age composition of discards from 1995 and 1996 (Figure B4); however, poor sampling in those years adds uncertainty to this assertion. The 1997 discard estimate is dominated by age-2 fish from the 1995 year class, probably as a result of minimum size and mesh regulations implemented in late 1996 and early 1997 (Figure B4). The 1998 and 1999 discard length samples suggest high discarding of the 1997 year class at age 1 in 1998 and at age-2 in 1999 (Figure B5). The usual discarding of age-2 fish was also high in 1998 (1996 year class) (Figure B4). The discarding of age-1 scup was lower in 1999 (1998 year class) compared to 1998 (1997 year class), which is likely a result of lower recruitment in the 1998 year class (Figure B5). The 2000 discard estimate is dominated by age-1 fish (1999 year class), suggesting high recruitment in 1999 (Figure B5). Evidence for discarding of a strong 1999 year class is further demonstrated in the 2001 discard estimates (Figure B6).

Recreational Catch

Scup is an important recreational species, with the greatest proportions of catch taken in the Southern New England states and New York. Estimates of the recreational catch in numbers were obtained from the NMFS Marine Recreational Fishery Statistics Survey (MRFSS) for 1979-2000. These estimates were available for three categories: type A - fish landed and available for sampling, type B1 - fish landed but not available for sampling, and type B2 - fish caught and released. The estimated recreational landings (types A and B1) in weight for 1979-2000 averaged 2,018 mt per year (Table B1). The MRFSS data indicated that recreational landings have composed about 27% of the commercial and recreational total since 1979 (Figure B1). The 1998 estimate of 395 mt is the lowest of the 1979-2001 time series, and about 56% of the available 1998 harvest limit. Recreational landings in 2001 were 1,933 mt, similar to the time series average.

No length frequency distribution data on scup discards were collected in the MRFSS program. Mortality attributable to discarding in the recreational fishery has been reported to range from 0-15% (Howell and Simpson 1985) and from 0-13.8% (NEFSC 2000). Howell and Simpson (1985) found mortality rates to be positively correlated with size because of the tendency for larger fish to take the hook deep in the esophagus or gills. Williams more clearly demonstrated increased mortality with depth of hook location, as well as handling time, but found no association between mortality rate and fish size. Discard mortality from 5 to 15% in the recreational fishery appears reasonable based on these studies. Previous assessments have assumed a recreational fishery discard mortality rate of 15% (NEFSC 1995, 1997, 1998, 2000).

Sampling intensity for lengths varied from 48 to 451 mt/100 lengths in the recreational fishery (Table B4). Sampling in all years except one from 1979 - 1987 failed to satisfy the informal criterion of 200 mt/100 lengths. This criterion was met from 1988 - 1998 when sampling intensity varied from 193 to 48 mt/100 lengths. Sampling did not meet the criteria in 1999 - 2001 with intensities ranging from 323 to 451 mt/100 lengths. Numbers at length for recreational landings were determined based on available recreational fishery length-frequency samples pooled by half years over all regions and fishing modes. The 1998-2001 recreational length frequencies were not converted to age because no age-structured analyses were included in recent assessment work as a result of inadequate commercial fishery sampling. Almost all of the recreational catch is estimated to be above the 7 in (18 cm) recreational fishery minimum size limit (Figures B7, B8).

Total Catch

Estimates of total catch are given in Table B11. These estimates include commercial and recreational landings and discards. The earliest catches in the 1960-2002 time series are the least reliable due to uncertainty about the level of distant water fleet (DWF) catch, recreational catch (50% reduction from interpolations made in Mayo 1982 for 1960-1978), and commercial fishery discard (GM D/L ratio from 1989-2001 applied to all earlier years). Commercial discards for 1989-2001 were estimated using the GMDL ratio method. The working group expressed some uncertainty regarding the magnitude of the 1998 GMDL ratio, so an average of the 1997 and 1999 GMDL ratios was calculated and applied to the 1998 estimated landings to generate a discard estimate for 1998.

For years in which no discard data were collected (prior to 1989), commercial landings were raised by the GMDL ratios for 1989-2001. A discard mortality rate of 100% was assumed since there are no published estimates of commercial discard mortality rates for scup. Recreational discard estimates by weight for 1981-2001 were based on the assumptions that discarded scup occurred in the same relative proportions as illegally landed fish and that 15% of recreational discards die of hooking mortality (Howell and Simpson 1985, NEFSC 1995, 1997, 1998, 2000). Because discard lengths and weights are not collected in the MRFSS program, mean weight at size/age in the discards was set equal to mean weight at size/age of the illegal landings. Indirect estimates (by ratio to commercial landings) of recreational catch and commercial fishery discards extended the catch series back to 1960 (NEFSC 1998).

STOCK ABUNDANCE AND BIOMASS INDICES

Research Vessel Survey Indices

The fishery-independent surveys provide information about relative abundance and biomass. Indices of scup abundance and biomass have been calculated from catch-per-tow data from research vessel surveys by the Northeast Fisheries Science Center (NEFSC), Massachusetts Division of Marine Fisheries (MADMF), Rhode Island Division of Fish and Wildlife (RIDFW), Connecticut Department of Environmental Protection (CTDEP), New York Department of Environmental Conservation (NYDEC), New Jersey Bureau of Marine Fisheries (NJBMF), and the Virginia Institute of Marine Science (VIMS). Details on the methods employed in the state surveys are given in historical assessment documentation (NEFSC 1997, 1998, 2000).

NEFSC Surveys

The NEFSC spring and fall surveys provide the longest time series of fishery-independent indices for scup. NEFSC spring and fall abundance and biomass indices exhibit considerable year-to-year variability (Table B12). While biomass levels from 1979 through 2001 have been much lower than in earlier years, the 2002 spring index is the largest in the time series (Figure B9). The 2002 spring biomass index (13.46 kg/tow) is almost three times the second highest spring index, which was observed in 1978 (4.56 kg/tow). The spring abundance indices are similar; in 2002, the estimated index of spring abundance is the highest observed in the series (167.93 number/tow), about twice the 1970 index (78.50 number/tow). These dramatic increases are evident across all ages in the estimated spring numbers at age (Table B13). Though the winter survey only started in 1992, the estimated 2002 abundance and biomass indices are the largest within the series (Table B15; Figure B11). Similar to the spring estimates, numbers at age estimated for the 2002 winter survey are also exceptionally large (Table B15). Though the NEFSC fall indices have shown improvement in recent years, the 2001 fall abundance and biomass indices are much smaller than those observed in 1999 and 2000 (Table B12; Figure B10). Fall estimates of numbers at age in 2001 do not reflect relatively large values from which corresponding 2002 spring numbers at age might be expected to derive (Table B13; Figure B10).

Indices of scup spawning stock biomass per tow (SSB kg/tow) were developed from the NEFSC spring offshore strata series for use as minimum biomass indices for stock rebuilding in

response to Sustainable Fisheries Act (SFA) considerations (NEFSC 1998). SAW 27 selected a 3-year moving average of the NEFSC spring SSB index as a representative measure of scup SSB based on the characteristics of the survey age structure and the magnitude of the survey catch. FMP Amendment 12 defined the threshold biomass index as the maximum observed value of this 3-year moving average - 2.77 SSB kg/tow (Table B12; Figure B12). The most recent average SSB index (2000-2002) is 3.20 SSB kg/tow, which exceeds this threshold.

MADMF Survey

The MADMF spring survey catches are characterized by scup age-1 and older. The spring biomass and abundance indices have dropped sharply from a high in the early 1980s to relatively low levels through the remainder of the time series, with the exception of spikes in 1990 and 2000 (Table B16; Figure B13). The 2001 spring index shows a decline to levels seen prior to the year 2000 increase. The MADMF fall indices are more variable than the spring indices, but also exhibit a decreasing trend in abundance and biomass over time (Table B16; Figure B14). The fall index is dominated by age-0 scup and does not reveal a strong 1997 year-class, but does indicate a strong 1999 year-class.

RIDFW Survey

The RIDFW spring survey typically catches scup age-1 and older. The spring indices show nominal levels of scup abundance through 1999 followed by a dramatic peak in 2000 (Table B17; Figure B15). The 2001 spring index exhibits a decline in abundance, though it is still larger than any other index in the time series prior to 2000. The spring biomass indices demonstrate very low scup biomass through 1999, but a significant increase is seen in 2000 and has continued to rise through 2001. The RIDFW fall survey is dominated by the presence of age-0 scup. Fall abundance indices show a general increase to its 1993 peak, followed by a steep decline in 1994 (Table B17; Figure B16). The fall survey gives evidence of a steady rise in abundance since that drop. The fall biomass trends are similar to the RI abundance patterns, giving evidence to a recent increase in biomass.

CTDEP Survey

The CTDEP spring survey is largely composed of age-1 scup, similar to the other surveys. The spring abundance indices exhibit relatively low levels through the survey period, with the exception of a dramatic peak in 2000, similar to the RIDFW spring abundance index (Table B18; Figure B17). The 2001 spring abundance and biomass indices for scup are 7.2 fish/tow and 2.85 kg/tow, respectively. Both values are lower than in 2000, but still substantially larger than any index prior to 2000. The CTDEP spring survey actually caught twice as much by weight in 2001 compared to 2000 (4,250.2 kg/120 tows in 2001 vs 2263.1 kg/120 tows in 2000; D. Simpson, pers. comm.). Numbers caught were 28,119 fish in 2001 and 36,531 fish in 2000 so the index dropped a lot more than indicated by the total catch. This is likely a result of the schooling behavior of scup, which allowed for several 'big hits' in 2001. The scup were more spread out in 2000 although there were still a few 'big hits'. Another indication of the tighter aggregation seen in the 2001 CTDEP spring survey is the % of tows where scup were present: 72% in 2000 and only 49% in 2001. The CTDEP fall survey, which is dominated by age-0 scup, indicates that scup numbers were relatively stable during the survey period, except for relatively large values in 1991, 1999, and 2000 (Table B19; Figure B18). As with the spring indices, the increases seen in 1999 and 2000 did not persist through

2001.

NJBMF Survey

The NJBMF abundance and biomass indices exhibit variable patterns over the time series. Relatively high values were observed from 1989 to 1993, lower values from 1994 to 1996/97, a peak in 1999, and a gradual decline in recent years. (Table B20; Figure B19).

VIMS Survey

The VIMS age-0 scup survey shows a general decline in abundance from relatively high levels peaking in 1990 and 1993 to relatively low levels from 1994 to 2000 (Table B21; Figure B20). The VIMS 2001 index suggests a potentially large increase in abundance.

NYDEC Survey

NYDEC provides both yearling (June-Aug) and young-of-year (Aug-Oct) indices for scup abundance. The yearling indices are generally low throughout the time series (Table B22; Figure B21A - note scale). Within the yearling series, there are three distinct peaks in relative abundance seen in 1989, 1985, and most recently in 2000. The 2000 index is the highest within the yearling indices. The YOY index shows fairly low levels over the survey periods, with periods of slightly elevated abundance levels evident in the early and late 1990s and a dramatic peak in 2000, which is the highest in the series (Table B22; Figure B21B).

Coherence Among Surveys

Previous assessments have been concerned with the conflicting pieces of evidence presented by the fishery-independent survey indices. The various indices have been inconsistent in their portrayal of relative population trends. For that reason, coherence among survey indices was evaluated in historical assessments of scup (NEFSC 1987, 1995, 1997). Correlation analyses yielded no consistent trends or patterns. Any significant correlations detected were sporadic and inconsistent between ages. The most recent SARC workshops abandoned formal correlation analyses and concluded that the various surveys likely measure different spatial and temporal components of the stock and those differences are reflected in the survey indices (NEFSC 1998, 2000). Correlation analyses were revisited in 2001 and results were similar to those found in previous assessment work (ASMFC 2001). The addition of one year of data (2001) is not expected to improve results from the correlation analyses, and so the analyses were not updated this year.

The spring indices are indicative of trends in adult biomass (age-1 and older) as indexed by mean weight per tow. Perhaps the most interesting trend is the dramatic increase observed in the 2002 NEFSC spring and winter abundance and biomass indices (Figures B9, B11). Estimates for 2002 are not yet available from the remaining surveys, but RIDFW spring biomass indices reflect a substantial increase in 2000 that continues through 2001 (Figures B15). The VIMS YOY indices also hint at an upward trend for 2001 (Figure B20). The remaining spring survey indices do not suggest an increase in scup biomass in 2001. The fall survey indices are mostly representative of age-0 fish and exhibit considerable inter-annual variability. Overall, fall indices appear to show evidence of strong recruitment in the 1999-2001 time period, which is also demonstrated in the YOY indices (VIMS and NYDEC). However, the NEFSC fall, CTDEP fall, and NYDEC YOY indices suggest

2001 recruitment was much lower than recent highs.

Spatial Patterns

Patterns in the spatial distribution of NEFSC spring survey catches were investigated to identify potential factors that may have influenced the marked increase in the 2002 NEFSC spring survey biomass and catch-at-age indices (Tables B12,B13; Figure B9). In previous years scup have been aggregated in deep water towards the northern end of their range (Figure B22). The 2001 NEFSC spring survey results exhibited a distribution similar to the historically observed patterns (Figure B23). This year, however, scup were also found in shallower water and spread from the Hudson Canyon to the mouth of the Chesapeake Bay (Figure B24). This same pattern was evident in the 2002 winter survey, though it was not as extreme. The magnitude of the 2002 spring survey catches ranged from 0.1 to 505.1 kg/tow in the 26 tows that observed scup (Figure B25). In contrast, the 2001 spring survey observed 15 positive scup tows ranging from 0.1 to 34 kg/tow. The 2002 spring survey also saw a greater number of larger scup than in most previous years, a trend reflected in many recent state surveys. The observed changes in distribution and relative biomass are attributable to changes in annual availability to the survey gear and variations in environmental conditions. Such factors have likely influenced the short-lived peaks and troughs observed in almost all of the state survey indices.

MORTALITY AND STOCK SIZE ESTIMATES

Natural Mortality

Instantaneous natural mortality (M) for scup was assumed to be 0.20 (Crecco *et al.* 1981, Simpson *et al.* 1990).

Catch Curve Analyses

In SAW 27, catch curve analyses based on the NEFSC autumn and spring surveys were used to estimate total mortality for scup (NEFSC 2000). These estimates were variable and considered imprecise. The fishery-independent surveys are thought to under-sample larger fish and so catch curve analyses based on these surveys will tend to overestimate Z . The absence of older scup from the survey catches may be due to a lack of availability and/or selectivity. The SAW 27 panel recommended research to investigate factors affecting size-specific availability to research surveys.

In 2001, both Massachusetts and Rhode Island initiated programs to age scup from commercial samples. Though the lack of a time series makes it difficult to incorporate this information into an analysis, catch curve analyses were applied to provide a general indication of current fishing mortality. The Rhode Island samples were taken from commercial fish traps. Sampled fish ranged from 1 to 8 years of age and most were age-3. Catch curve analysis yielded an estimated Z of 1.12, which corresponds to an F of 0.92 if M is assumed to be 0.20. Massachusetts provided scup age samples summarized over all fisheries and market categories. Estimates of Z ranged from 0.99 to 1.22 ($F \sim 0.79$ to 1.00) depending on the ages used to fit the catch curve.

Relative Exploitation Index

A relative exploitation index based on landings and spawning stock biomass was constructed to identify trends in exploitation rates. The index used total landings (1,000s of lbs.) and the NEFSC spring SSB survey (kg/tow; three-year average) as a proxy for biomass. Relative exploitation was equal to landings divided by the SSB index and scaled by dividing by 1,000. This index reflected the mortality on age 2 and older scup because landings and catch in the SSB survey generally comprised scup ages 2 and older. Total catch and spring survey results were not used to derive an exploitation index because of the uncertainty associated with the discard estimates. To confirm observed trends in exploitation, an additional index was calculated based on total landings (1,000s of lbs.) and the NEFSC fall survey (kg/tow; three-year average).

The relative exploitation index indicated that the exploitation of scup was relatively low in the 1980s and high in the 1990s (Table B23; Figure B26). The low exploitation rates in the early 1980s were consistent with Mayo's 1983 assessment of scup. There was a general increasing trend in exploitation through the mid-1990s followed by a steady decline through 2001, the lowest observed value in the time series. Relative exploitation based on the 3-year moving average of the fall survey index also suggested a declining trend in relative exploitation since the mid-1990s, though there is evidence of a slight increase in 2000 (Figure B27).

BIOLOGICAL REFERENCE POINTS

FMP Amendment 12 defined overfishing for scup to occur when the fishing mortality rate exceeded the threshold fishing mortality rate of F_{MSY} . F_{MAX} was used as a proxy for F_{MSY} because F_{MSY} could not be reliably estimated for scup. F_{MAX} was most recently estimated to be 0.26 in SAW 27 (NEFSC 1998).

FMP Amendment 12 defined a threshold biomass index for stock rebuilding as the maximum value of a 3-year moving average of the NEFSC spring survey catch per tow of spawning stock biomass (1977-1979 = 2.77 SSB kg/tow). The most recent estimate of the average SSB index exceeds this threshold (3.20 SSB kg/tow, 2000-2002).

STOCK REBUILDING SCHEDULES

Long-Term Projections

According to the Sustainable Fisheries Act, the stock is to be rebuilt to a target biomass, which is greater than the biomass threshold, in ten years. Stock projections to assess projected stock status against existing rebuilding schedules were performed in the SAW 31 assessment using the NEFSC spring survey catch per tow at age estimates for 2000 (NEFSC 2000). The inability to estimate the absolute magnitude of F prevented an update of the previous forecast method for evaluating the SSB relative to the current biomass threshold. However, long-term projections of relative biomass were performed to get a sense of how exploitation may affect long-term population trends. The projections were based on the average of 2000-2002 NEFSC spring survey catch per tow

at age estimates, offshore strata only (Table B24). The survey catch per tow at age values were projected into the next respective age in each time step, with an assumed $M=0.20$ and yearly recruitment at age 1 assumed equal to the long-term median catch per tow at age 1, NEFSC spring survey offshore strata (1977-2002 median = 5.15). The projections assumed different intrinsic rates of fishing mortality: $F=0.00$, $F=0.26$ (target for 2002), $F=0.45$ (target for 2000-2001), $F=0.72$ (target for 1997-1999), $F=1.00$, and $F=2.00$. Relative biomass was estimated by multiplying catch per tow at age by a partial recruitment vector and a weight at age vector (NEFSC 1995). Recruitment to the spawning stock was 13% at age 1, 75% at age 2, 99% at age 3, and 100% at ages 4 and older (NEFSC 1995). Projections were for 15 years.

Projections of relative biomass trends were dependent on the assumed fishing mortality rate (Figure B28). At $F=0.00$, trends in scup stock biomass showed a steady increase in the first eight years followed by a moderate decline. Long-term projections based on an assumed $F=0.26$ showed a moderate increase in the early years and gradually decreased to a level equivalent to approximately 40% of the peak predicted relative biomass within the time series. When fishing mortality was assumed $F=0.45$ or higher, relative biomass demonstrated a long-term decline.

Note that these projections were made solely to explore estimated trends in long-term relative biomass. The difficulties in estimating current fishing mortality precluded the application of reliable stock projections. Additionally, these projections assumed constant recruitment for all years. Realistically, recruitment will exhibit inter-annual variability that will affect predictions of SSB relative to the biomass threshold at a given F . Catchability differences between age groups as well as annual variability in catchability have not been accounted for in these projections. As such, consideration should be given to potential fluctuations in recruitment, changes in catchability, and environmental variation when interpreting stock projections.

CONCLUSIONS

The stock is not overfished, but stock status with respect to overfishing cannot currently be evaluated. The 2001 estimate of spawning stock biomass (2000-2002 average= 3.20 SSB kg/tow), based on the 3-year moving average of the NEFSC SSB spring survey, exceeds the established biomass index threshold (2.77 SSB kg/tow). The change in stock status results from the extremely high survey observation in 2002 and its contribution to the calculation of the moving average. The spring survey index for 2002 is highly uncertain since the abundance of all age groups in the survey increased substantially as compared with the 2001 results. Though the relative exploitation rates have declined in recent years, the absolute value of F cannot be determined. Survey observations indicate strong recruitment and some rebuilding of age structure.

Management should continue efforts to further reduce fishing mortality rates and minimize fishery discards to rebuild the stock.

The stock can likely sustain modest increases in catches, but managers should do so with due consideration of high uncertainty in stock status determination.

Major uncertainties in estimating total catch continue to preclude an analytical stock assessment for scup. As such, the SARC concluded that a quantitative analysis of the population would be inappropriate as the basis for management decisions for scup at this time. The SARC panel expressed concerns about the failure to collect sufficient catch information that has impeded the development of scup assessments in the past. Several previous SARC panels (SAW 25, 27, 31) have concluded that new or enhanced data reporting or sampling are required to produce a reliable assessment. Members of the current panel emphasized that an analytical formulation for scup will not be feasible until the quality and quantity of the input data (biological sampling and estimates of all components of catches) are significantly improved for an adequate time series.

SARC COMMENTS

The SARC commented on possible explanations for the marked increase in the 2002 spring survey indices. In previous years scup have been aggregated in deep water towards the northern end of their range. This year, however, they were also found in shallower water and distributed from the Hudson canyon to the mouth of the Chesapeake. This same pattern was evident in the winter survey, though it was not as extreme. The 2002 spring survey also saw a greater number of larger scup than in most previous years, a trend reflected in many recent state surveys. The SARC had difficulty interpreting the spring 2002 survey results due to potential changes in the availability of the fish, performance of the gear and/or sampling variability. Availability to the survey gear and variations in environmental conditions were recognized as potential factors in the high survey values and additional analyses were recommended to evaluate their potential effects. In addition, the SARC agreed that the standard error for the survey indices should be included in the current document. Future assessments should include confidence intervals generated using stratified bootstraps.

Estimates of recreational and commercial discards were discussed at length. A number of methods were reviewed, but a consensus opinion on a satisfactory option could not be reached due to the absence of sufficiently reliable data. As a result, the SARC determined that while the document should include discards for the commercial and recreational fisheries, there was insufficient confidence in the estimates to support a production model. The SARC recognized the ongoing problems associated with discard estimates and recommended that the Scup Stock Assessment Working Group design a sampling program that would provide enough information to determine discard estimates in the future. Future documents should also include a description of the statistical properties of each method used to estimate discards to help determine which is most appropriate.

The SARC reviewed a method of estimating relative exploitation rate, fishing mortality and stock biomass using CPUE from the recreational private boat fishery. Though it was recognized as having potential for providing useful information on trends, the SARC concluded that it needed further development (e.g., consistency in the fishing mortality metric and the effort information used in CPUE indices) prior to being included in an advisory document and used as a management tool.

The SARC discussed the stock projections provided by the Scup Stock Assessment Working

Group. The age structure and recruitment rate, both derived from 2002 estimates, were determined to be inappropriate. The SARC recommended that the average age structure from 2000, 2001 and 2002 and the median recruitment rate from 1977 through 2002 be used to eliminate the bias associated with single year estimates. The SARC considered that this method of projection should be treated with caution especially beyond year one, due to uncertainties in input information.

The SARC discussed the possibility of recommending revised reference points, possibly including a revised biomass threshold or a biomass target. It was determined that, as confidence in the data used in the analytical assessment was very low, there was insufficient basis for forwarding revised reference points to the Council.

SOURCES OF UNCERTAINTY

The majority of the uncertainty pertaining to the population assessment of scup is related to biological sampling and estimates of all components of catches for scup. The main concerns include:

- **NER commercial fishery biological sampling**
Inadequate sampling of strata (market categories and statistical areas) that have substantial landings of scup
- **Dealer / VTR databases**
Uncertainty with method of allocation of landings by market category to statistical area
Unreported landings by dealers
- **NEFSC sea sampling**
Inadequate for developing reliable estimates of scup discards (limited sample size and questionable as to representative nature of sea sampling data for scup)
Intensity of length frequency sampling may not be representative of discards
- **Historical catch estimation**
Uncertainty about the level of distant water fleet (DWF) catch (1963-1981), recreational catch (MRFSS data not available prior to 1979), and commercial fishery discards (no sea sampling for discards prior to 1989)
- **Assumption of 100% commercial discard mortality**

RESEARCH RECOMMENDATIONS

1. The SARC discussed some of the reasons why the research recommendations from previous SARCs had not been adequately addressed. There is currently no mechanism for accountability, resulting in other research needs taking priority. It was suggested that summaries of research recommendations be forwarded to the NRCC for review and comment, followed by a feasibility analysis. At that point a list of priorities and perhaps assignments for research could be made. The SARC recommends that a working group be developed to assess what group would be best suited to address each research need.
2. Increased and more representative sea and port sampling of the various fisheries in which scup are landed and discarded is needed to adequately characterize the length composition of both landings and discards. The current level of sampling, particularly of the discards, seriously impedes the development of analytic assessment and forecasts of catch and stock biomass for this stock. A pilot study to develop a sampling program to estimate discards should be implemented. Expanded age sampling of scup from commercial and recreational catches is required, with special emphasis on the acquisition of large specimens.
3. Commercial discard mortality had previously been assumed to be 100% for all gear types. The committee recommends that studies be conducted to better characterize the mortality of scup in different gear types to more accurately assess discard mortality.
4. Additional information on compliance with regulations (e.g. length limits) and hooking mortality is needed to interpret recreational discard data.
5. Biological studies to investigate factors affecting annual availability of scup to research surveys and maturity schedules.
6. Investigate the statistical properties of the three commercial discard estimation approaches presented for consideration in future analyses.
7. Quantify the percentage of commercial fishery trips that had discards, but no landings, and evaluate how such trips contribute to the total commercial fishery discard estimate.
8. Continue exploration of relative biomass and relative exploitation calculations based on CPUE data from the recreational private boat fishery.
9. Explore other approaches for analyzing survey data, including bootstrap resampling methods to generate approximate confidence intervals around the survey index point estimates.
10. In the absence of reliable estimates of the catch, consideration should be given to simple forward projection models that rely on trends from the survey indices in the absence of catch information.

11. Design an optimal sampling plan that would be considered for implementation by the fishery observer sampling, recreational and commercial port sampling program.
12. Explore alternative biomass indices for development of biomass proxies for reference point determination based on multiple survey indices.
13. Evaluate the current biomass reference point and consider alternative proxy reference points such as B_{MAX} (the relative biomass associated with F_{MAX}).
14. Surveys should be evaluated to test the assumption of equal catchability at age in projections (i.e. through forward projection methods).
15. Explore alternative decision support methodologies for updating TALs directly from relative trends in abundance without relying on direct estimates of F .

REFERENCES

- ASMFC. 2001. Current data and evaluation of fishery-independent indices for population assessment of scup. Report of the Summer Flounder, Scup, and Black Sea Bass Technical Committee, ASMFC.
- Cogswell, S.J. 1960. Summary of tagging operations, July 1, 1959 through June 30, 1960, U.S. Bur. Comm. Fish., Woods Hole Laboratory, Lab. Ref. No. 60-1.
- Cogswell, S.J. 1961. Summary of tagging operations, July 1, 1960 through June 30, 1961, U.S. Bur. Comm. Fish., Woods Hole Laboratory, Lab. Ref. No. 61-12.
- Correia, S. 1995. A priori evaluation of fishery-independent indices for the winter flounder assessment. Report of the 21st Northeast Regional Stock Assessment Workshop (21st SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent.
- Crecco, V.G. Maltezos, and P. Howell-Heller. 1981. Population dynamics and stock assessment of the scup, *Stenotomus chrysops*, from New England waters. Conn. Dept. Environ. Protect., Mar. Fish., Completion Rep. No. 3-328-R-2 CT, 62 p.
- Dery, L. and C. Rearden. 1979. Report of the state-federal scup (*Stenotomus chrysops*) age and growth workshop. National Marine Fisheries Service, Northeast Fisheries Center, Woods Hole Laboratory Lab. Ref. Doc. 79-57.

- Hamer, P.E. 1970. Studies of the scup, *Stenotomus chrysops*, in the Middle Atlantic Bight. New Jersey Div. Fish, Game and Shellfish, Misc. Rep. No. 5M, 14 p.
- Hamer, P.E. 1979. Studies of the scup, *Stenotomus chrysops*, in the Middle Atlantic Bight. New Jersey Div. Fish, Game and Shellfish, Misc. Rep. No. 18M, 67 p.
- Howell, P.T. and D.G. Simpson. 1985. A study of marine recreational fisheries in Connecticut. March 1, 1981 B February 18, 1984. CTDEP, Fed. Aid to Sport Fish Restoration F54R, Final Rep., 60p.
- Mayo, R.K. 1982. An assessment of the scup, *Stenotomus chrysops* (L.), population in the Southern New England and Middle Atlantic regions. NMFS, NEFC, Woods Hole Lab. Ref. Doc. No. 82-46, 60 p.
- Morse, W.W. 1978. Biological and fisheries data on scup, *Stenotomus chrysops* (Linnaeus). NMFS, NEFC, Sandy Hook Lab. Tech. Ser. Rep. No. 12, 41 p.
- NEFSC. 1987. Report of the 4th Northeast Regional Stock Assessment Workshop (4th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 87-07, 102 p.
- _____. 1989a. Report of the 7th Northeast Regional Stock Assessment Workshop (7th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 89-04, 108 p.
- _____. 1989b. Report of the 9th Northeast Regional Stock Assessment Workshop (9th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 89-08, 71 p.
- _____. 1990. Report of the 11th Northeast Regional Stock Assessment Workshop (11th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 90-09, 121 p.
- _____. 1993. Status of Fishery Resources off the Northeastern United States. NOAA Tech. Mem. NMFS-F/NEC-101. 140 p.
- _____. 1995. Report of the 19th Northeast Regional Stock Assessment Workshop (19th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 95-08, 221 p.
- _____. 1997. Report of the 25th Northeast Regional Stock Assessment Workshop (25th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 97-14, 143 p.

- _____. 1998. Report of the 27th Northeast Regional Stock Assessment Workshop (27th SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 98-15, 350 p.
- _____. 2000. Report of the 31st Northeast Regional Stock Assessment Workshop (31st SAW): Stock Assessment Review Committee (SARC) consensus summary of assessments. Northeast Fish. Sci. Cent. Ref. Doc. 00-15, 400 p.
- Neville, W.C. and G.B. Talbot. 1964. The fishery for scup with special reference to fluctuations in yield and their courses. U.S. Fish Wildl. Serv. Spec. Sci. Rept. - Fish. No. 459, 61 p.
- Sisson, R.T. 1974. The growth and movement of scup (*Stenotomus chrysops*) in Narragansett Bay, RI and along the Atlantic Coast. RI Division of Fish and Wildlife Completion Report, 3-138-R-3, 21 p.
- Wigley, S., M. Terceiro, A. DeLong, and K. Sosebee. 1997. Proration of 1994-1996 commercial landings of cod, haddock and yellowtail flounder. SAW 24 SARC Working Paper Gen 4, 32 p.

Table B1. Landings (mt) of scup from Maine through North Carolina. Landings include revised Massachusetts landings for 1986-1997.

Year	Commercial	Recreational	Total
1979	8,585	1,198	9,783
1980	8,424	3,109	11,533
1981	9,856	2,636	12,492
1982	8,704	2,361	11,065
1983	7,794	2,836	10,630
1984	7,769	1,096	8,865
1985	6,727	2,764	9,491
1986	7,176	5,264	12,440
1987	6,276	2,806	9,082
1988	5,943	1,936	7,879
1989	3,984	2,521	6,505
1990	4,571	1,878	6,449
1991	7,081	3,668	10,749
1992	6,259	2,001	8,260
1993	4,726	1,450	6,176
1994	4,392	1,192	5,584
1995	3,073	596	3,669
1996	2,945	1,016	3,961
1997	2,188	543	2,731
1998	1,896	395	2,291
1999	1,505	855	2,360
2000	1,207	2,365	3,572
2001	1,729	1,933	3,662
mean	5,340	2,018	7,358

Table B2. Commercial landings (mt) of scup by state. One mt was landed in DE in 1995, included with MD 1995 total. Landings include revised Massachusetts landings for 1986-1997.

Year	ME	MA	RI	CT	NY	NJ	MD	VA	NC	Total
1979		782	3,123	92	1,422	2,159	21	397	589	8,585
1980	1	706	2,934	17	1,294	2,310	32	531	599	8,424
1981		523	2,959	44	1,595	2,990	9	1,054	682	9,856
1982		545	3,203	25	1,473	1,746	2	1,042	668	8,704
1983		672	2,583	49	1,103	2,536	13	536	302	7,794
1984		540	2,919	32	904	2,217	6	673	478	7,769
1985		387	3,583	41	861	1,493	17	74	271	6,727
1986		875	2,987	67	893	1,895	14	273	172	7,176
1987	5	735	2,162	301	911	1,817		232	113	6,276
1988	9	536	2,832	359	687	1,334	1	127	58	5,943
1989	32	579	1,401	89	603	1,219	1	45	15	3,984
1990	4	696	1,786	165	755	1,005	4	75	81	4,571
1991	16	553	2,902	287	1,223	1,960	15	56	69	7,081
1992		655	2,676	193	1,043	1,475	17	73	127	6,259
1993		556	1,332	148	729	1,822	10	76	53	4,726
1994		354	1,514	142	688	1,456	7	92	139	4,392
1995		310	1,045	90	511	1,084	2	20	11	3,073
1996		436	773	99	377	1,141	20	72	27	2,945
1997		676	486	50	376	596	1	2	1	2,188
1998		435	361	44	282	758	5	4	7	1,896
1999		300	581	44	206	361		13		1,505
2000		161	461	65	287	232		1		1,207
2001		149	734	45	297	479	1	24		1,729
mean	11	529	1,971	108	805	1,482	10	239	223	5,340

Table B3. Commercial landings (mt) of scup by major gear types. All North Carolina landings in 1990-2001 are assumed to be obtained by otter trawls. Mid-water paired trawl landings are combined with other gears during 1994 and later. Landings include revised Massachusetts landings for 1986-1997.

Year	Otter trawl	Paired trawl	Floating trap	Pound net	Pots and traps	Hand lines	Other gear	Total mt
1979	6,387	146	1,305	429	26	215	77	8,585
1980	6,192	160	1,559	194	8	303	8	8,424
1981	7,836	79	1,291	246	49	306	49	9,856
1982	6,563	104	1,514	244	9	226	44	8,704
1983	5,861	398	850	390	8	265	22	7,794
1984	5,617	272	1,266	295	8	287	24	7,769
1985	4,856	417	1,022	229	5	182	16	6,727
1986	5,163	540	629	332	9	493	10	7,176
1987	4,607	237	590	193	213	423	13	6,276
1988	4,142	166	1,052	53	44	396	90	5,943
1989	3,174	89	193	74	104	334	16	3,984
1990	3,205	200	505	60	239	340	22	4,571
1991	5,217	152	988	40	258	395	31	7,081
1992	4,371	94	934	67	303	450	40	6,259
1993	3,865	46	166	25	202	402	20	4,726
1994	3,416		331	79	76	340	150	4,392
1995	2,204		331	42	57	215	224	3,073
1996	2,196		229	8	120	374	18	2,945
1997	1,491		86	12	104	489	6	2,188
1998	1,379		11	4	98	390	14	1,896
1999	1,005		140	30	77	184	69	1,505
2000	773		56		78	205	95	1,207
2001	1,088		229	65	52	215	80	1,729
mean	3,939	207	664	141	93	323	49	5,340

Table B4. Summary of the sampling intensity for scup in the NER (ME-VA) commercial and coastal recreational fisheries.

Year	NER Commercial fishery				Coastal Recreational fishery		
	No. of samples	No. of lengths	NER Landings (mt)	Sampling intensity (mt/100 lengths)	No. of lengths	Estimated landings (A + B1) (mt)	Sampling intensity (mt/100 lengths)
1979	10	1,250	7,996	640	322	1,198	372
1980	26	3,478	7,825	225	1,263	3,109	246
1981	16	2,005	9,174	458	642	2,068	322
1982	81	9,896	8,036	81	1,057	3,100	293
1983	72	7,860	7,492	95	1,384	3,432	248
1984	60	6,303	7,291	116	943	1,434	152
1985	31	3,058	6,456	211	741	3,282	443
1986	54	5,467	7,004	128	2,580	5,908	229
1987	61	6,491	6,163	95	777	2,980	384
1988	85	8,691	5,885	68	2,156	2,414	112
1989	46	4,806	3,969	83	4,111	3,248	79
1990	46	4,736	4,490	95	2,698	2,007	74
1991	31	3,150	7,012	223	4,230	3,634	86
1992	33	3,260	6,163	189	4,419	2,110	48
1993	23	2,287	4,673	204	2,206	1,341	61
1994	22	2,163	4,253	197	1,374	1,188	86
1995	22	2,487	3,062	123	822	595	72
1996	61	6,544	2,918	45	526	1,016	193
1997	37	3,732	2,187	59	399	543	136
1998	41	4,022	1,889	47	286	395	138
1999	56	6,040	1,505	25	265	855	323
2000	22	2,245	1,207	54	524	2,365	451
2001	40	3,934	1,729	44	1,038	1,933	186

Table B5. Summary of sampling for scup in the Northeast Region sea sampling program.

OT= number of trips sampled in which otter trawl gear was used. H1 = first half year; H2 = second half year. SS discard reflects the estimate of discard based on applying ratios of discards to landings by trip, stratified by landings level (< 300 kg per trip, = > 300 kg per trip) to reported weighout landings. Estimates of tonnage reflecting potential discard in the entire fishery are from the method used in the SARC 27 assessment. (Eleven length measurements from scallop dredges were not used in 1995.)

Year	Trips		Lengths			SS Discard (mt)	Intensity (mt/100 lengths)
	All	OT	H1	H2	Total		
1989	63	61	4,449	2,910	7,359	2,173	30
1990	52	52	2,582	781	3,363	3,877	115
1991	104	91	1,237	1,780	3,017	3,535	117
1992	106	53	1,158	0	1,158	5,749	496
1993	64	29	275	154	429	1,434	334
1994	7	7	99	119	218	773	355
1995	20	18	162	383	556	2,046	368
1996	32	27	1,093	435	1,528	1,522	100
1997	58	45	750	1	751		
1998	41	33	618	64	682		
1999	40	35	586	89	675		
2000	72	62	3,981	762	4,743		
2001	67	67	1,473	401	1,874		

Table B6. GMDL . Summary NEFSC Domestic Sea Sampling program data for scup during 1997-2001. Geometric mean discards to landings ratios (retransformed, mean ln-transformed D/L per trip) are stratified by half-year period (HY1, HY2) and trip landings level (< 300 kg, => 300 kg). N is number of sea sample trips with both scup landings and discard, which are used to calculate the per trip discard to landings ratios. Corresponding dealer landings are from the NEFSC database.

1997		Trips <300 kg			Trips =>300 kg			
Period	GM D/L	N	Dealer Landings (mt)	Estimated Discard (mt)	GM D/L	N	Dealer Landings (mt)	Estimated Discard (mt)
HY 1	0.8957	17	258	231	0.8221	4	1,244	1,023
HY 2	0.8957	0	279	250	0.8221	0	413	340
Total			537	481			1,657	1,362
1998		Trips <300 kg			Trips =>300 kg			
Period	GM D/L	N	Dealer Landings (mt)	Estimated Discard (mt)	GM D/L	N	Dealer Landings (mt)	Estimated Discard (mt)
HY 1	2.401	7	196	471	121.71	1	920	111,973
HY 2	3.126	10	281	878	121.71	0	496	60,368
Total			477	1,349			1,416	172,341
1999		Trips <300 kg			Trips =>300 kg			
Period	GM D/L	N	Dealer Landings (mt)	Estimated Discard (mt)	GM D/L	N	Dealer Landings (mt)	Estimated Discard (mt)
HY 1	1.742	6	245	427	3.766	2	785	2,956
HY 2	1.742	0	178	310	3.766	0	299	1,126
Total			423	737			1,084	4,082

Table B6. GMDL continued .

2000		Trips <300 kg			Trips =>300 kg			
Period	GM D/L	N	Dealer Landings (mt)	Estimated Discard (mt)	GM D/L	N	Dealer Landings (mt)	Estimated Discard (mt)
HY 1	4.5818	13	196	898	0.6018	2	655	394
HY 2	3.5001	1	292	1,022	0.6018	0	63	38
Total		14	488	1,920		2	718	432

2001		Trips <300 kg			Trips =>300 kg			
Period	GM D/L	N	Dealer Landings (mt)	Estimated Discard (mt)	GM D/L	N	Dealer Landings (mt)	Estimated Discard (mt)
HY 1	0.8916	10	180	160	0.9185	4	1,013	930
HY 2	0.4606	2	307	141	0.9185	0	290	266
Total		14	487	302		4	1,303	1,197

Table B7. AGDL . Summary NEFSC Domestic Sea Sampling program data for scup during 1997-2001. Aggregate discards to landings ratios (summed D/summed L for all trips in stratum) are stratified by half-year period (HY1, HY2) and trip landings level (< 300 kg, => 300 kg). N is number of sea sample trips in the stratum which are used to calculate the aggregate ratio. Corresponding dealer landings are from the NEFSC database.

1997		Trips <300 kg			Trips =>300 kg				
Period	AG D/L	N	Dealer Landings (mt)	Estimated Discard (mt)	AG D/L	N	Dealer Landings (mt)	Estimated Discard (mt)	
HY 1	6.45	29	258	1,664	0.92	4	1,244	1,144	
HY 2	6.45	0	279	1,800	0.92	0	413	380	
Total			537	3,464			1,657	1,524	
1998		Trips <300 kg			Trips =>300 kg				
Period	AG D/L	N	Dealer Landings (mt)	Estimated Discard (mt)	AG D/L	N	Dealer Landings (mt)	Estimated Discard (mt)	
HY 1	9.77	16	196	1,915	121.71	1	920	111,973	
HY 2	5.80	16	281	1,630	121.71	0	496	60,368	
Total			477	3,545			1,416	172,341	
1999		Trips <300 kg			Trips =>300 kg				
Period	AG D/L	N	Dealer Landings (mt)	Estimated Discard (mt)	AG D/L	N	Dealer Landings (mt)	Estimated Discard (mt)	
HY 1	20.59	14	245	5,045	3.77	2	785	2,959	
HY 2	20.59	0	178	3,665	3.77	0	299	1,127	
Total			423	8,710			1,084	4,087	

Table B7. AGDL continued .

2000		Trips <300 kg			Trips =>300 kg			
Period	AG D/L	N	Dealer Landings (mt)	Estimated Discard (mt)	AG D/L	N	Dealer Landings (mt)	Estimated Discard (mt)
HY 1	12.36	31	196	2,423	0.69	2	655	452
HY 2	26.13	29	292	7,630	0.69	0	63	43
Total			488	10,053			718	495

2001		Trips <300 kg			Trips =>300 kg			
Period	AG D/L	N	Dealer Landings (mt)	Estimated Discard (mt)	AG D/L	N	Dealer Landings (mt)	Estimated Discard (mt)
HY 1	4.79	37	180	862	1.44	4	1,013	1,459
HY 2	10.82	22	307	3,322	0.00	4	290	0
Total			487	4,184			1,303	1,459

Table B8. DELTA. Summary NEFSC Domestic Sea Sampling program data for scup during 1997-2001. Mean differences (kg) between landings and discard (D = landings - discard, per trip) are stratified by half-year period (HY1, HY2) and trip landings level (< 300 kg, => 300 kg). N is number of sea sample trips in the stratum which are used to calculate the mean difference in stratum, which is then applied to the landings of every trip in the NEFSC dealer database to calculate a discard for each trip (discard = landings - (D)).

1997		Trips <300 kg			Trips =>300 kg				
Period	D	N	Dealer Landings (mt)	Estimated Discard (mt)	D	N	Dealer Landings (mt)	Estimated Discard (mt)	
HY 1	-49.4	29	258	624	167.7	4	1,244	1,118	
HY 2	-18.6	6	279	477	167.7	0	413	355	
Total			537	1,101			1,657	1,473	

1998		Trips <300 kg			Trips =>300 kg				
Period	D	N	Dealer Landings (mt)	Estimated Discard (mt)	D	N	Dealer Landings (mt)	Estimated Discard (mt)	
HY 1	-53.2	16	196	544	-72707	1	920	45,857	
HY 2	-46.1	16	281	846	-72707	0	496	37,140	
Total			477	1,390			1,416	82,997	

1999		Trips <300 kg			Trips =>300 kg				
Period	D	N	Dealer Landings (mt)	Estimated Discard (mt)	D	N	Dealer Landings (mt)	Estimated Discard (mt)	
HY 1	-97.1	14	245	978	-3271	2	785	2,660	
HY 2	-11.9	19	178	242	-3271	0	299	1,494	
Total			423	1,220			1,084	4,154	

Table B8. DELTA continued .

2000		Trips <300 kg			Trips =>300 kg				
Period	D	N	Dealer Landings (mt)	Estimated Discard (mt)	D	N	Dealer Landings (mt)	Estimated Discard (mt)	
HY 1	-194.6	31	196	1,143	1062	2	655	148	
HY 2	-39.3	29	292	804	1062	0	63	44	
Total			488	1,947			718	192	

2001		Trips <300 kg			Trips =>300 kg				
Period	D	N	Dealer Landings (mt)	Estimated Discard (mt)	D	N	Dealer Landings (mt)	Estimated Discard (mt)	
HY 1	-34.5	37	180	161	-1868.5	4	1,013	931	
HY 2	-10.7	22	307	142	998	4	290	0	
Total			487	303			1,303	931	

Table B9. SUMMARY. A summary of landings, discards, and aggregate discards to landings ratio (D:L) from the three alternative methods of discard calculation.

Year	Landings (mt)	GMDL Discards (mt)	GMDL D:L ratio	AGDL Discards (mt)	AGDL D:L ratio	Delta Discards (mt)	Delta D:L ratio
1997	2,194	1,843	0.84	4,988	2.27	2,574	1.17
1998	1,893	173,690	91.75	175,886	92.91	84,387	44.58
1999	1,507	4,819	3.20	12,797	8.49	5,374	3.57
2000	1,206	2,352	1.95	10,548	8.75	2,139	1.77
2001	1,790	1,499	0.84	5,643	3.15	1,234	0.69

Table B10. Comp. Comparison of Sea Sampled (SS) and Vessel Trip Report (VTR) trawl gear geometric mean discard ratios for scup (Re-transformed mean of the natural log of discard to landed ratio on trips catching scup. In VTR, data was subset to include only trawl trips that reported some discard of any species). Values in bold were substituted for inadequate data in discard calculation (i.e., missing or unrepresentative SS trips; see report text).

Year	Reporting System	Trip Landings < 300 kg		Trip Landings => 300 kg	
		Half-year 1	Half-year 2	Half-year 1	Half-year 2
1994	SS	0.81	0.74	0.11	0.18
	VTR	0.11	0.10	0.05	0.03
1995	SS	1.62	1.77	0.48	0.48
	VTR	0.14	0.23	0.05	0.04
1996	SS	0.74	0.91	0.48	0.48
	VTR	0.44	0.23	0.89	0.05
1997	SS	0.90	0.90	0.82	0.82
	VTR	0.14	0.37	0.04	0.05
1998	SS	0.88	1.14	4.81	n/a
	VTR	0.28	0.64	0.11	0.05
1999	SS	0.55	n/a	1.33	n/a
	VTR	0.25	0.43	0.04	0.05
2000	SS	4.58	3.50	0.60	n/a
	VTR	1.19	0.86	0.04	n/a
2001	SS	0.89	0.46	0.92	n/a
	VTR	0.64	0.27	0.06	0.08

Table B11. Total catch (mt) of scup from Maine through North Carolina, 1960 – 2001.

Year	Commercial		DWF	Recreational		Total Catch
	Landings	Discards	Landings	Landings	Discards	
1960	22236	11198	0	3689	75	37199
1961	20944	10548	0	3642	74	35208
1962	20831	10491	0	3593	73	34988
1963	18884	9510	5863	3457	71	37785
1964	17204	8664	459	3274	67	29668
1965	15785	7950	2089	3200	65	29089
1966	11960	6023	823	2425	49	21280
1967	8748	4406	896	1841	38	15928
1968	6630	3339	2251	1443	29	13692
1969	5149	2593	485	1085	22	9334
1970	4493	2263	288	982	20	8046
1971	3974	2001	889	836	17	7717
1972	4203	2117	1647	780	16	8763
1973	5024	2530	1783	1095	22	10455
1974	7106	3579	958	1360	28	13031
1975	7623	3839	685	1375	28	13550
1976	7302	3677	87	1159	24	12249
1977	8330	4195	28	1370	28	13951
1978	8936	4500	3	1230	25	14695
1979	8585	4324	0	1198	24	14130
1980	8424	4242	16	3109	62	15854
1981	9856	4964	1	2636	53	17510
1982	8704	4383	0	2361	47	15496
1983	7794	3925	0	2836	57	14612
1984	7769	2158	0	1096	30	11053
1985	6727	4184	0	2764	54	13729
1986	7176	2005	0	5264	87	14532
1987	6276	2537	0	2806	38	11657
1988	5943	1657	0	1936	31	9567
1989	3984	2173	0	2521	39	8717
1990	4571	3877	0	1878	38	10364
1991	7081	3535	0	3668	78	14362
1992	6259	5749	0	2001	47	14056
1993	4726	1434	0	1450	28	7638
1994	4392	773	0	1192	37	6394
1995	3073	2046	0	596	33	5748
1996	2945	1522	0	1016	47	5530
1997	2188	1843	0	543	25	4599
1998	1896	3830	0	395	8	6129
1999	1505	4819	0	855	17	7196
2000	1207	2352	0	2365	50	5974
2001	1729	1499	0	1933	85	5246

Table B12. NEFSC spring and autumn trawl survey indices for scup. Strata set includes only offshore Strata 1-12, 23, 25, and 61-76 for consistency over entire time series. Strata set excludes inshore strata 1-61 that are included in the 1984 and later indices at age in later tables. **Note that Spring 2002 indices are preliminary.**

Year	Spring No./tow	Spring Kg/tow	Spring SSB kg/tow	Spring SSB 3-yr avg	Autumn No./tow	Autumn Kg/tow
1963					2.12	1.21
1964					118.70	2.23
1965					3.84	0.62
1966					2.00	0.41
1967					29.38	1.46
1968	59.21	2.25	0.94		14.35	0.54
1969	2.26	0.40	0.39	0.88	99.41	4.48
1970	78.50	3.01	1.30	1.09	10.34	0.22
1971	70.91	2.41	1.57	1.28	7.730	0.25
1972	49.80	2.30	0.98	1.21	40.56	2.34
1973	3.62	1.19	1.09	1.38	22.82	0.93
1974	30.28	3.24	2.06	1.92	9.94	1.01
1975	14.01	3.12	2.61	1.73	52.21	3.40
1976	4.09	0.63	0.53	2.50	161.14	7.35
1977	42.46	4.48	4.35	2.49	32.64	1.71
1978	39.85	3.49	2.59	2.77	12.17	1.32
1979	22.42	1.95	1.38	1.69	15.77	0.61
1980	9.31	1.31	1.09	1.12	11.05	0.92
1981	14.72	1.16	0.90	1.00	67.14	3.01
1982	7.88	1.16	1.02	0.65	25.47	1.17
1983	0.80	0.29	0.03	0.46	4.59	0.34
1984	8.52	0.51	0.33	0.24	24.03	1.22
1985	14.67	0.80	0.37	0.68	68.30	3.56
1986	11.74	1.30	1.33	0.98	46.19	1.66
1987	10.82	1.21	1.24	1.10	5.76	0.15
1988	25.41	1.26	0.73	0.66	5.75	0.09
1989	1.63	0.12	0.00	0.35	5.70	0.30
1990	1.17	0.39	0.31	0.26	16.53	0.83
1991	12.61	0.75	0.45	0.32	9.52	0.43
1992	6.79	0.40	0.21	0.32	16.19	1.12
1993	2.93	0.33	0.31	0.18	0.43	0.04
1994	1.54	0.09	0.03	0.15	3.59	0.11
1995	2.90	0.22	0.12	0.06	24.72	0.91
1996	0.53	0.03	0.02	0.08	4.46	0.23
1997	0.91	0.11	0.11	0.06	16.92	0.88
1998	40.04	0.87	0.05	0.08	25.35	0.69
1999	1.70	0.12	0.09	0.08	85.23	2.07
2000	6.71	0.33	0.11	0.25	99.33	4.79
2001	13.03	0.80	0.54	3.20	20.28	1.11
2002	167.93	13.46	8.94			

Table B13. NEFSC spring trawl survey stratified mean number of scup per tow at age. Strata set includes offshore strata 1-12, 23, 25, 61-76, and inshore strata 1-61. **Note that Spring 2002 indices are preliminary.**

Spring Year	0	1	2	3	4	5	6	7	8	9	10	11	Total	age 2+	age 3+
1984	4.95	1.55	0.18	0.10	0.02								6.88	1.85	0.30
1985	9.84	1.65	0.17	0.01									11.98	1.83	0.18
1986	0.84	8.06	0.19										9.47	8.25	0.19
1987	3.76	2.96	1.49	0.61	0.03	0.02	0.02	0.02	0.01			0.01	8.90	5.15	2.19
1988	13.66	6.90	0.14	0.02			0.02	0.05					20.98	7.13	0.23
1989	0.66	0.42	0.08	0.01									1.36	0.51	0.09
1990	0.14	0.24	0.25	0.15	0.08	0.11	0.03						1.01	0.86	0.62
1991	8.26	0.42	0.89	0.16									10.17	1.47	1.05
1992	4.60	0.71	0.06	0.04	0.05	0.10							5.46	0.96	0.25
1993	0.50	1.62	0.14	0.09	0.02								2.37	1.87	0.25
1994	1.07	0.08	0.03										1.24	0.11	0.03
1995	1.84	0.36	0.08	0.04									2.35	0.48	0.12
1996	0.35	0.04	0.02	0.01									0.42	0.07	0.03
1997	0.27	0.52	0.08										0.87	0.60	0.08
1998	32.15	0.08	0.01										32.24	0.09	0.01
1999	0.82	0.54	0.01										1.37	0.55	0.01
2000	4.78	0.58	0.06										5.42	0.64	0.06
2001	6.38	4.07	0.06		0.02								10.53	4.15	0.08
2002	97.91	12.78	21.47	2.64	0.25								135.05	37.14	24.36

Table B14. NEFSC autumn trawl survey stratified mean number of scup per tow at age. Strata set includes offshore strata 1-12, 23, 25, 61-76, and inshore strata 1-61.

Autumn Year	0	1	2	3	4	5	6	7	8	9	10	11	Total	age 2+	age 3+
1984	47.64	9.20	0.34	0.03	0.01		0.01						59.96	0.39	0.05
1985	61.22	11.53	1.10	0.26	0.06	0.05							74.71	1.47	0.37
1986	70.19	6.58	0.57		0.01								77.36	0.58	0.01
1987	49.93	29.85	0.46	0.01									80.45	0.47	0.01
1988	47.44	15.95	0.67	0.10									64.22	0.77	0.10
1989	176.37	25.92	0.66	0.03									202.99	0.69	0.03
1990	77.45	9.21	0.75	0.04									87.46	0.79	0.04
1991	151.62	12.51	0.07	0.02									164.24	0.09	0.02
1992	25.92	14.51	1.66	0.04	0.02								42.15	1.72	0.06
1993	46.78	9.76	0.32										56.86	0.32	0.00
1994	39.54	3.92	0.04	0.01									43.52	0.05	0.01
1995	33.04	2.61	0.08	0.01									35.74	0.09	0.01
1996	24.42	2.86	0.43	0.01									27.73	0.44	0.01
1997	46.91	0.61	0.02		0.01								47.66	0.03	0.01
1998	57.73	9.64	0.09	0.03	0.01								67.50	0.13	0.04
1999	96.06	9.77	1.37	0.07	0.01								107.28	1.45	0.08
2000	98.72	20.60	3.14	0.48	0.11	0.07							123.12	3.80	0.66
2001	91.84	10.32	1.82	0.12	0.04	0.01							104.15	1.99	0.17

Table B15. NEFSC Winter trawl survey indices of abundance for scup, offshore survey strata 1-12 and 61-76. The 1992, 1993, and 1996 lengths are aged with the corresponding annual spring survey age-length key. **Note that Winter 2002 indices are preliminary.**

Year	Mean number per tow	Mean kg per tow
1992	63.18	2.76
1993	25.71	2.73
1994	17.09	0.66
1995	67.01	2.18
1996	18.29	1.19
1997	13.90	0.32
1998	46.92	1.20
1999	15.04	0.71
2000	24.21	1.33
2001	55.49	1.58
2002	259.51	7.49

Winter Year	Age										Total	age 2+	age 3+
	0	1	2	3	4	5	6	7	8				
1992		57.61	4.75	0.19	0.09	0.10	0.45				63.18	5.57	0.82
1993		2.51	22.05	0.56	0.57	0.02					25.71	23.19	1.15
1994		16.31	0.73	0.02	0.02	0.01					17.09	0.78	0.05
1995		64.94	1.87	0.15	0.01	0.01	0.02	0.01			67.01	2.07	0.20
1996		12.95	5.31	0.03	0.01						18.29	5.34	0.04
1997		13.27	0.52	0.11							13.90	0.64	0.11
1998		45.62	0.75	0.22	0.21	0.08	0.03	0.01			46.92	1.30	0.55
1999		12.48	2.41	0.12	0.02	0.01					15.04	2.56	0.15
2000		20.28	3.21	0.68	0.03			0.01			24.21	3.93	0.72
2001		48.54	6.48	0.36	0.09	0.02					55.49	6.95	0.47
2002		248.54	7.66	2.96	0.33	0.01	0.01				259.51	10.97	3.31

Table B16. MADMF trawl surveys' mean number of scup per tow and total mean weight(kg) per tow for spring (survey regions 1-3) and fall (all survey regions).

Year	Spring		Fall	
	No./Tow	Kg/Tow	No./Tow	Kg/Tow
1978	88.20	31.11	1765.90	14.01
1979	74.48	17.64	1088.60	11.38
1980	191.91	42.05	1112.20	11.77
1981	292.37	17.40	911.20	13.51
1982	10.37	0.97	2012.70	8.61
1983	24.42	3.40	1536.60	12.22
1984	17.80	6.50	907.20	11.54
1985	65.85	3.33	605.70	11.41
1986	43.76	7.28	727.60	8.57
1987	6.01	1.36	530.40	7.29
1988	13.98	2.08	1325.90	13.37
1989	13.05	1.97	555.00	7.34
1990	141.74	21.21	1054.40	6.76
1991	28.62	6.04	1088.90	9.67
1992	14.26	2.47	2307.80	10.90
1993	18.41	4.08	957.40	9.94
1994	9.60	2.82	781.10	9.35
1995	48.30	2.72	481.70	3.88
1996	5.04	0.66	965.00	8.65
1997	3.21	0.71	874.10	6.88
1998	1.26	0.19	670.90	6.55
1999	11.26	1.87	1152.20	17.11
2000	266.94	15.49	821.56	10.97
2001	7.20	2.34	1143.78	9.39

Table B17. RIDFW spring and fall trawl survey mean number of scup per tow and mean weight (kg) of scup per tow.

Year	Spring		Fall	
	No./Tow	Kg/Tow	No./Tow	Kg/Tow
1981	12.49	0.40	196.22	2.54
1982	0.43	0.04	63.87	0.70
1983	3.59	0.32	173.63	2.75
1984	13.24	0.88	589.68	10.57
1985	8.30	0.41	74.27	1.51
1986	1.78	0.33	340.06	4.20
1987	0.04	0.01	314.20	4.73
1988	0.23	0.04	804.00	7.10
1989	0.17	0.04	326.86	6.62
1990	0.64	0.15	527.31	5.66
1991	2.93	0.57	655.69	16.62
1992	1.88	0.61	1105.51	9.10
1993	1.12	0.06	1246.35	8.90
1994	2.08	0.53	236.12	3.66
1995	4.33	0.53	423.02	5.03
1996	0.52	0.07	184.73	3.83
1997	1.93	0.15	597.90	6.04
1998	0.15	0.03	150.38	1.89
1999	0.38	0.07	832.22	12.39
2000	84.05	3.54	588.73	9.11
2001	29.68	5.08	1139.17	11.07

Table B18. CTDEP spring trawl survey mean number of scup per tow at age, total mean number per tow, and total mean weight (kg) per tow.

Year	Age														Total	Total	Age
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	No./Tow	Kg/Tow	2+
1984	0.49	1.31	0.59	0.30	0.08	0.00	0.00	0.00	0.00	0.03	0.02	0.00	0.00	0.00	2.80	0.64	2.31
1985	2.94	2.00	0.33	0.24	0.05	0.02	0.05	0.00	0.00	0.01	0.00	0.00	0.00	0.00	5.61	1.22	2.71
1986	4.44	1.65	0.99	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.40	0.78	2.79
1987	0.43	1.65	0.07	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.17	0.37	1.76
1988	1.18	0.30	0.51	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.11	0.32	0.88
1989	5.63	0.56	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.77	0.63	0.62
1990	2.56	2.06	0.21	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.25	0.61	2.30
1991	4.25	1.44	1.26	0.09	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.09	0.94	2.80
1992	0.39	1.21	0.09	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.75	0.48	1.36
1993	0.04	2.29	0.19	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.32	0.49	2.49
1994	0.81	2.03	0.93	0.10	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.88	0.58	3.09
1995	12.94	0.39	0.20	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.24	0.65	0.64
1996	5.20	2.48	0.07	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.25	0.73	2.56
1997	3.16	2.61	1.68	0.06	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.23	0.75	4.39
1998	10.07	0.58	0.12	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.25	0.75	0.76
1999	2.71	1.75	0.16	0.07	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.22	0.56	2.02
2000	124.51	17.18	4.24	0.20	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.46	4.56	21.71
2001	1.65	18.99	1.57	0.25	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.20	2.85	20.84

Table B19. CTDEP fall trawl survey mean number of scup per tow at age, total mean number per tow, and total mean weight (kg) per tow.

Year	Age											Total	Total	Age
	0	1	2	3	4	5	6	7	8	9	10	No./Tow	Kg/Tow	2+
1984	7.99	1.04	0.78	0.52	0.28	0.09	0.02	0.00	0.00	0.00	0.00	10.72	1.36	1.69
1985	25.01	4.71	0.40	0.59	0.19	0.04	0.03	0.00	0.00	0.00	0.00	30.97	2.50	1.26
1986	13.06	9.98	2.50	0.19	0.01	0.01	0.01	0.00	0.00	0.00	0.00	25.76	2.95	2.71
1987	12.47	4.17	1.25	0.58	0.06	0.01	0.01	0.00	0.00	0.00	0.00	18.54	1.79	1.91
1988	31.89	5.71	1.82	0.24	0.03	0.00	0.00	0.00	0.00	0.00	0.00	39.70	2.27	2.10
1989	40.88	22.60	1.51	0.08	0.01	0.00	0.00	0.00	0.00	0.00	0.00	65.09	3.65	1.61
1990	54.34	7.74	6.95	0.40	0.03	0.01	0.01	0.00	0.00	0.01	0.00	69.48	5.00	7.40
1991	291.58	17.03	1.76	1.04	0.15	0.01	0.00	0.00	0.00	0.00	0.00	311.57	8.30	2.95
1992	50.91	26.58	5.54	0.40	0.29	0.01	0.01	0.00	0.00	0.00	0.00	83.73	4.96	6.24
1993	74.06	1.83	1.02	0.12	0.01	0.01	0.00	0.00	0.00	0.00	0.00	77.06	3.72	1.16
1994	90.76	1.12	0.46	0.18	0.01	0.00	0.00	0.00	0.00	0.00	0.00	92.54	3.33	0.66
1995	32.46	26.52	0.14	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	59.14	4.63	0.15
1996	51.50	8.56	1.37	0.03	0.00	0.01	0.00	0.00	0.00	0.00	0.00	61.46	3.68	1.40
1997	31.79	8.68	0.63	0.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	41.28	2.49	0.81
1998	90.40	12.24	0.54	0.07	0.02	0.00	0.00	0.00	0.00	0.00	0.00	103.27	4.50	0.63
1999	498.18	30.93	8.35	0.19	0.02	0.01	0.00	0.00	0.00	0.00	0.00	537.68	22.72	8.57
2000	250.39	261.45	8.32	0.79	0.14	0.01	0.00	0.00	0.00	0.00	0.00	521.10	30.76	9.27
2001	140.51	16.90	18.42	1.61	0.19	0.03	0.00	0.00	0.00	0.00	0.00	177.64	11.28	20.24

Table B20. NJBMF trawl survey mean number of scup per tow and mean weight (kg) per tow.

Year	No./Tow	Kg/Tow
1988	475.82	14.62
1989	67.90	3.11
1990	67.39	4.12
1991	196.13	6.91
1992	224.11	7.56
1993	216.50	6.60
1994	80.15	3.18
1995	39.79	2.53
1996	30.33	0.95
1997	62.78	4.65
1998	209.50	5.72
1999	279.43	11.33
2000	206.94	6.78
2001	155.58	5.44

Table B21. VIMS age-0 scup index of abundance for Chesapeake Bay (geometric mean catch per tow, June-September).

Year	No./Tow	Lower CL	Upper CL	n
1988	2.07	1.24	3.21	92
1989	3.07	2.05	4.41	112
1990	4.92	3.14	7.45	112
1991	1.90	1.11	2.99	103
1992	0.65	0.41	0.93	104
1993	3.36	2.16	5.01	104
1994	0.90	0.53	1.35	104
1995	0.39	0.21	0.59	104
1996	0.54	0.29	0.83	104
1997	0.21	0.09	0.35	104
1998	0.50	0.28	0.76	79
1999	0.27	0.06	0.52	88
2000	0.13	0.02	0.25	107
2001	1.34	0.88	1.90	111

Table B22. NYDEC yearling (June-August) and young-of-the-year (August-September) \ scup indices (geometric mean catch per station).

Year	No./Tow	
	Yearling	YOY
1987	1.58	0.22
1988	0.80	0.50
1989	3.06	0.40
1990	0.37	1.97
1991	1.02	4.39
1992	0.66	3.76
1993	0.30	0.19
1994	0.18	1.77
1995	2.95	0.38
1996	0.41	0.26
1997	0.34	4.65
1998	0.37	10.42
1999	0.72	5.81
2000	5.58	61.66
2001	1.04	36.04

Table B23. Relative exploitation index for scup for 1981-2001. Landings are 1,000's of lbs. and SSB index values are kg/tow.

Year	Landings	Spring SSB (3-year average)	Relative Exploitation Index
1981	27,540	1.00	27.5
1982	24,394	0.65	37.5
1983	23,435	0.46	50.9
1984	19,544	0.24	81.4
1985	20,924	0.68	30.8
1986	27,425	0.98	28.0
1987	20,022	1.10	18.2
1988	17,370	0.66	26.3
1989	14,341	0.35	41.0
1990	14,218	0.26	54.7
1991	23,697	0.32	74.1
1992	18,210	0.32	56.9
1993	13,616	0.18	75.6
1994	12,311	0.15	82.1
1995	8,089	0.06	134.8
1996	8,732	0.08	109.2
1997	6,021	0.06	100.3
1998	5,051	0.08	63.1
1999	5,203	0.08	65.0
2000	7,875	0.25	31.5
2001	8,073	3.2	2.5

Table B24. NEFSC spring trawl survey stratified mean number of scup per tow at age. Strata set includes offshore strata 1-12, 23, 25, 61-76. **Note that Spring 2002 indices are preliminary.**

Year	Age											Total	
	1	2	3	4	5	6	7	8	9	10	11		
1977	6.62	32.08	3.54	0.16	0.04	0.01	0.01						42.46
1978	26.90	4.67	6.50	1.31	0.32	0.12	0.03						39.85
1979	15.63	4.04	0.88	1.28	0.37	0.06	0.13	0.02	0.01				22.42
1980	2.39	5.61	0.57	0.17	0.25	0.15	0.08	0.08	0.01				9.31
1981	10.78	2.16	1.15	0.17	0.14	0.05	0.15	0.12					14.72
1982	3.80	1.77	1.39	0.38	0.17	0.13	0.07	0.07	0.10				7.88
1983	0.70	0.03	0.06				0.01						0.80
1984	6.14	1.97	0.22	0.12	0.07								8.52
1985	12.11	2.32	0.20	0.04									14.67
1986	1.05	10.26	0.43										11.74
1987	4.57	3.60	1.81	0.74	0.04	0.02	0.03	0.01					10.82
1988	16.74	8.36	0.17	0.03	0.01	0.03	0.07						25.41
1989	0.79	0.74	0.09	0.01									1.63
1990	0.12	0.30	0.30	0.18	0.09	0.13	0.05						1.17
1991	10.61	0.70	1.11	0.19									12.61
1992	5.72	0.88	0.07	0.05	0.06	0.01							6.79
1993	0.61	2.02	0.17	0.11	0.02								2.93
1994	1.34	0.16	0.04										1.54
1995	2.29	0.44	0.11	0.05	0.01								2.90
1996	0.44	0.05	0.03	0.01									0.53
1997	0.17	0.64	0.10										0.91
1998	39.90	0.12	0.02										40.04
1999	1.03	0.67											1.70
2000	5.93	0.71	0.07										6.71
2001	7.90	5.03	0.08		0.02								13.03
2002	121.75	15.89	26.70	3.28	0.31								167.93

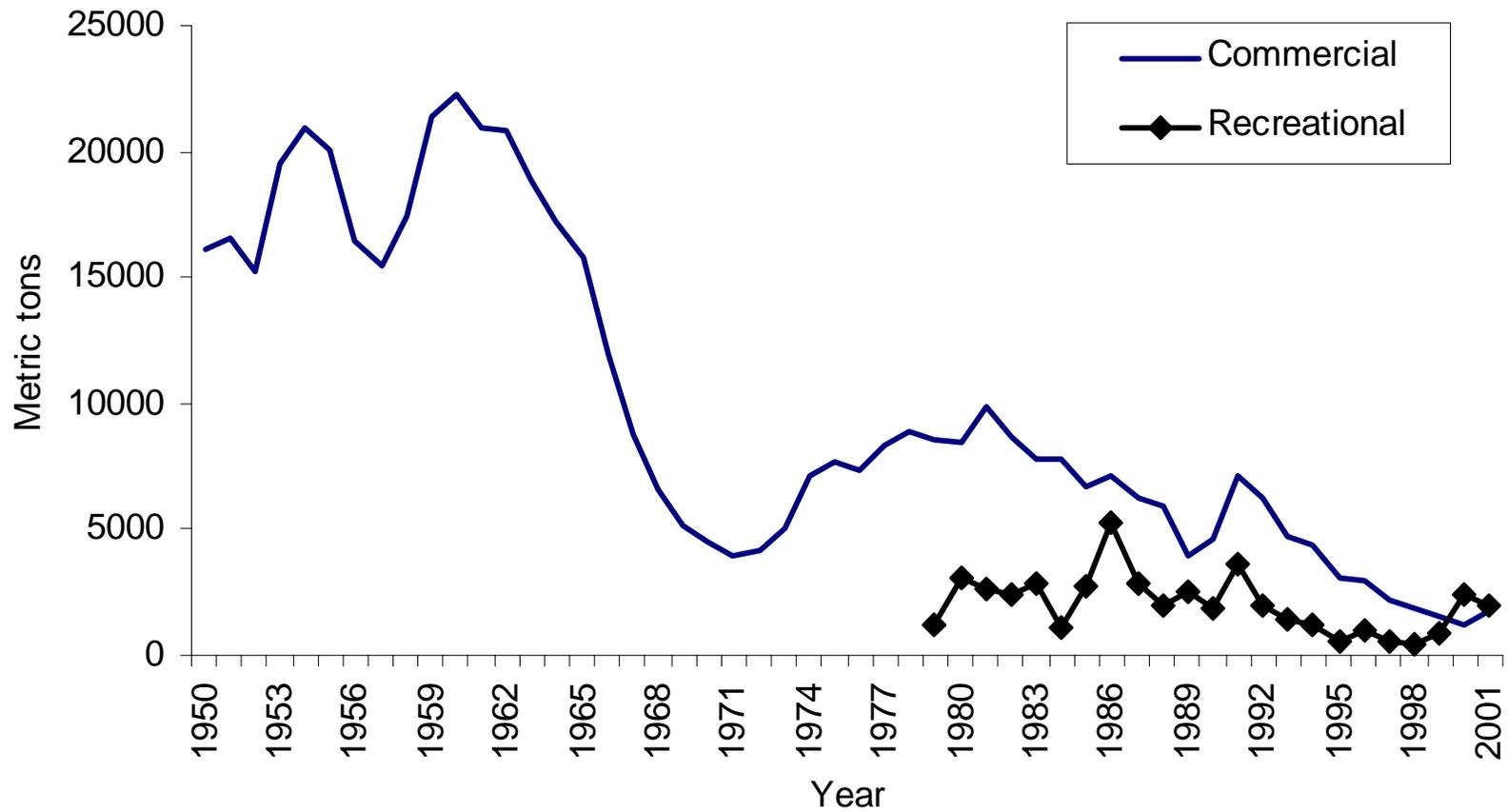


Figure B1. Landings of scup from Maine through North Carolina, including US commercial and recreational landings (1950-2001).

NER Commercial Scup Landings at Length

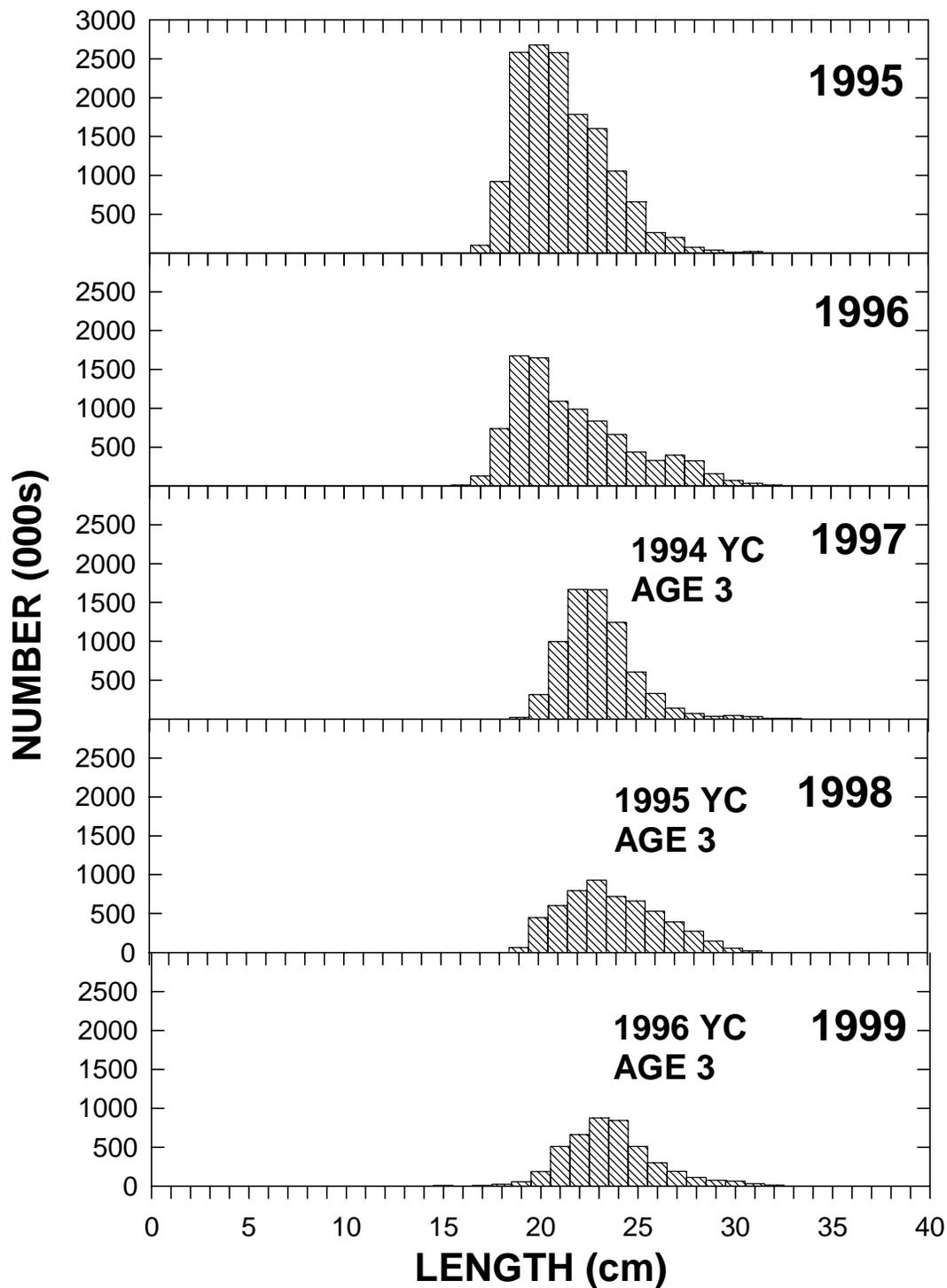


Figure B2. Northeast Region (NER; ME to VA) commercial fishery estimates of scup landings at length (fork length, cm) for 1995 to 1999.

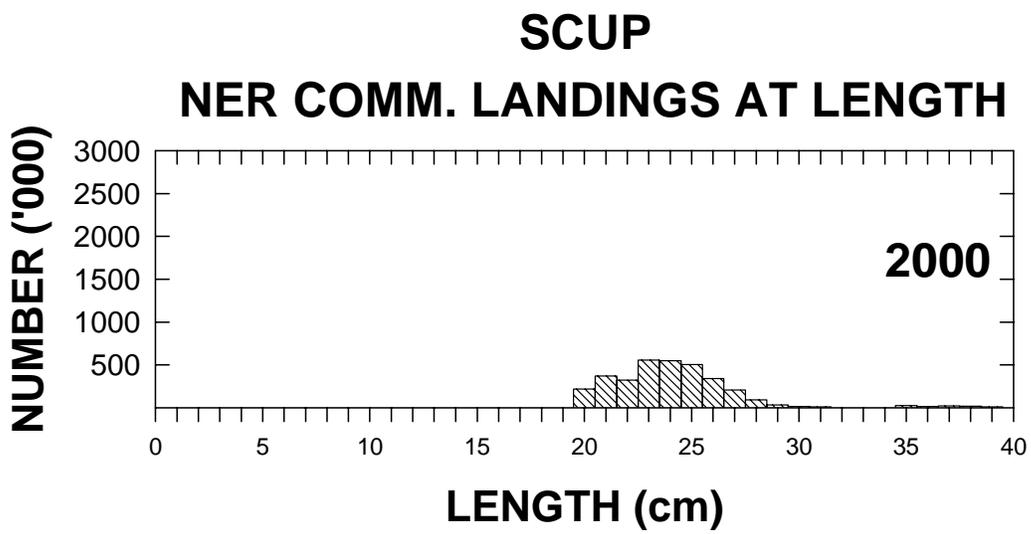


Figure B3. Northeast Region (NER; ME to VA) commercial fishery estimates of scup landings at length (fork length, cm) for 2000.

Scup Commercial Discards at Length

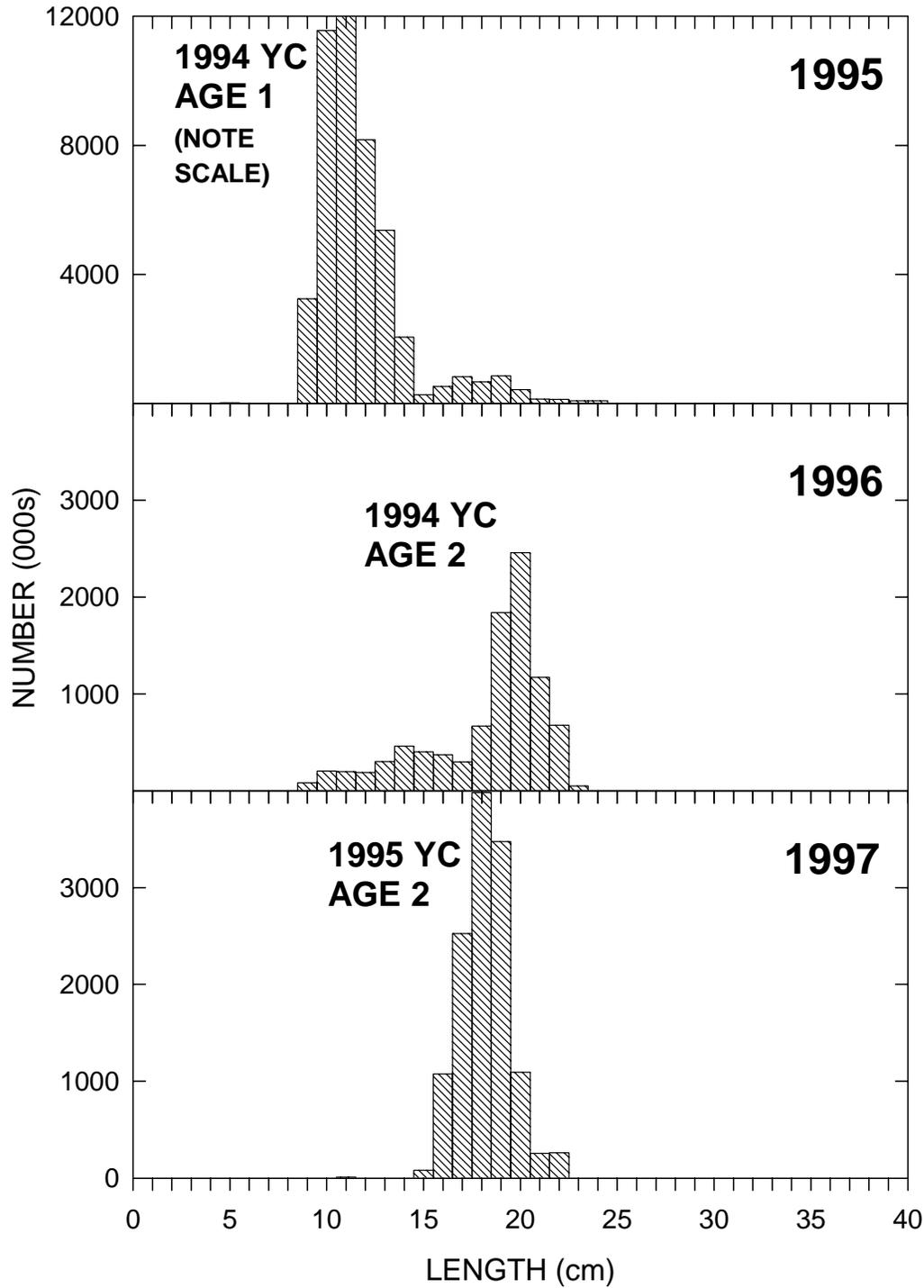


Figure B4. Northeast Region (NER; ME to VA) commercial fishery estimates of scup discards at length (fork length, cm) for 1995-1997.

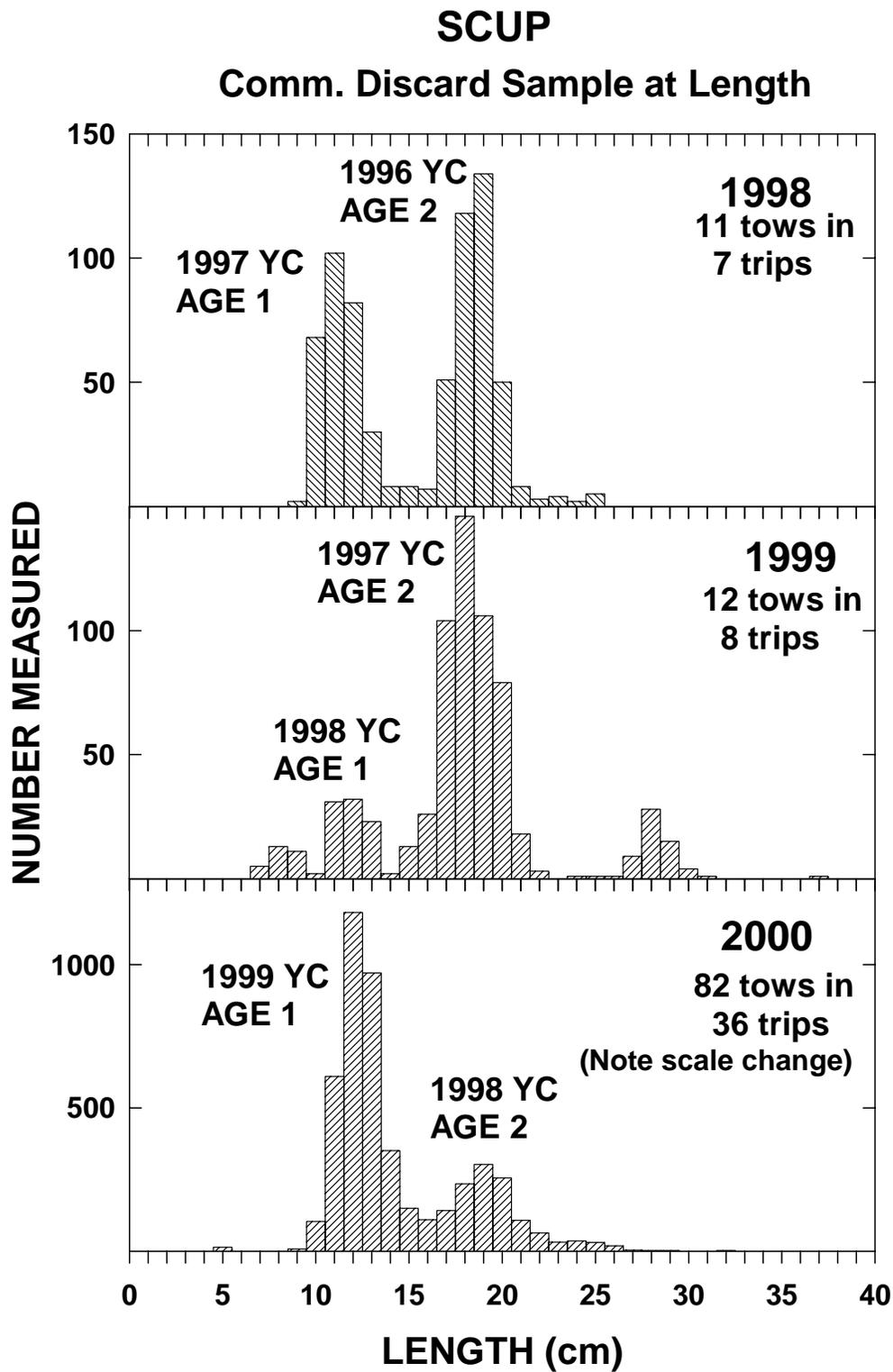


Figure B5. Northeast Region (NER; ME to VA) commercial fishery estimates of scup discards at length (fork length, cm) for 1998-2000.

SCUP

Comm. Discard Sample at Length

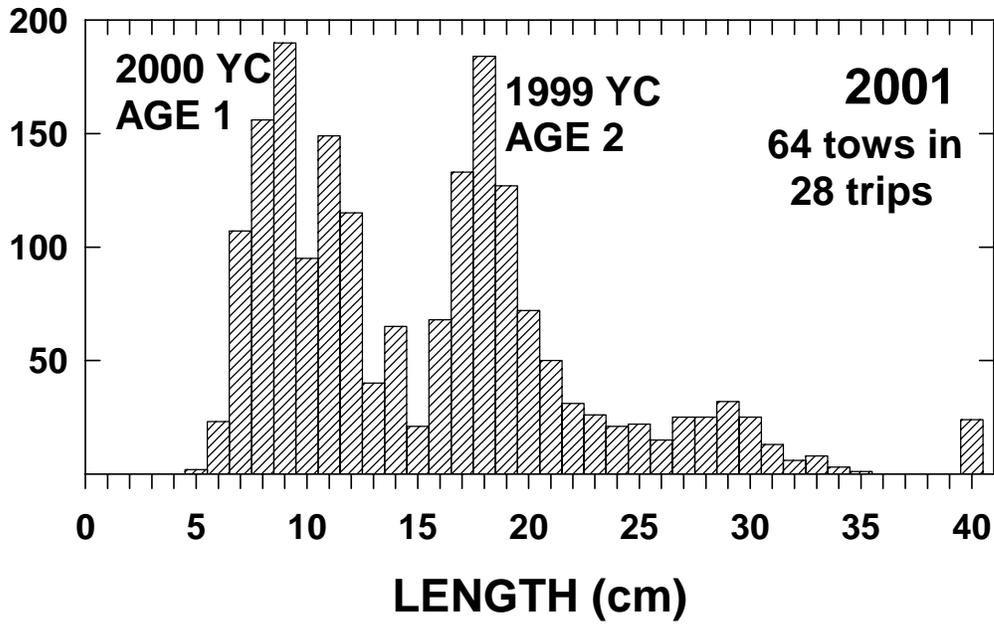


Figure B6. Northeast Region (NER; ME to VA) commercial fisher estimates of scup discards at length (fork length, cm) for 2001.

Recreational Estimated Catch at Length

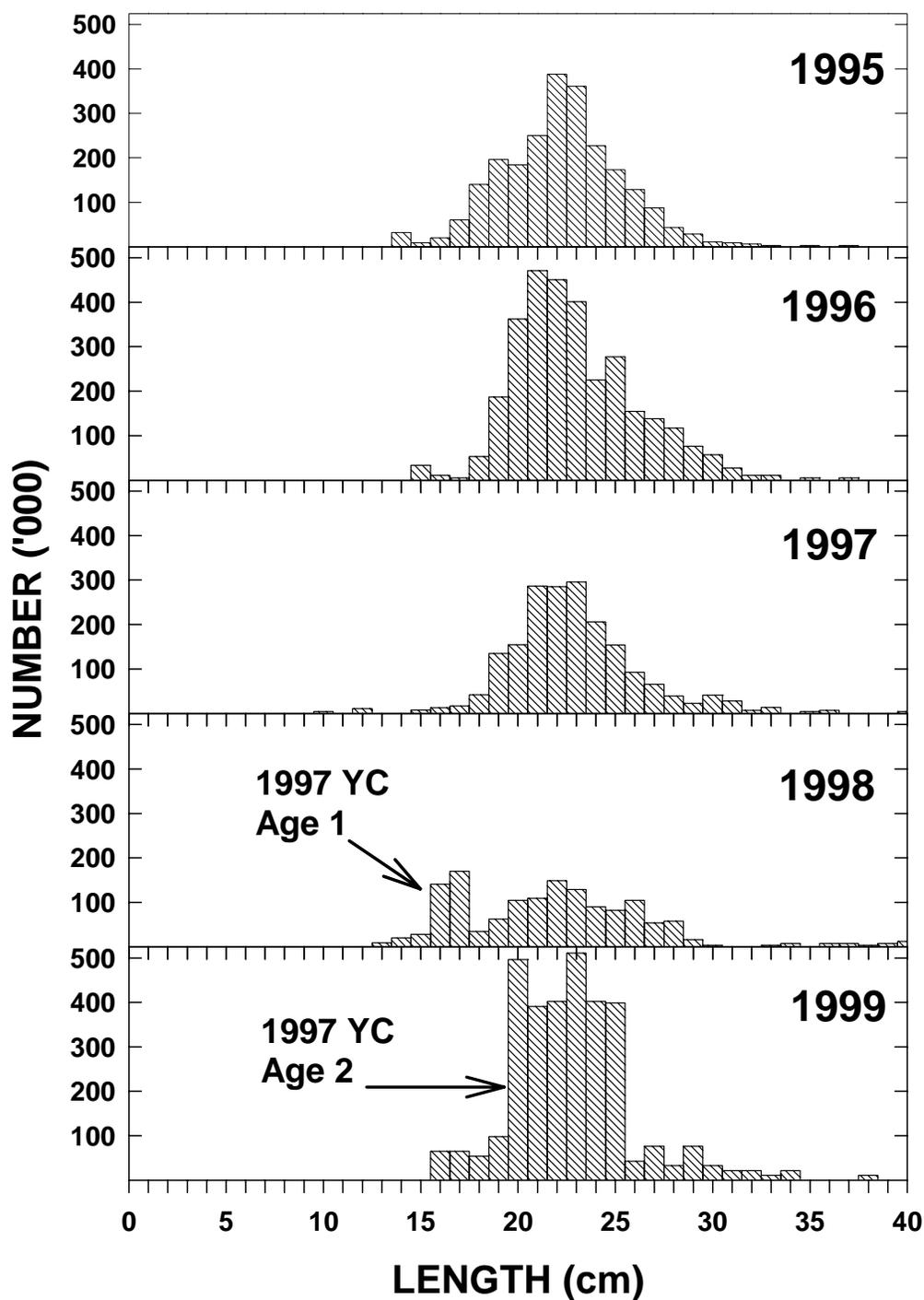


Figure B7. Coastal recreational fishery estimates of scup catch at length (fork length, cm; ME to NC) for 1995 to 1999.

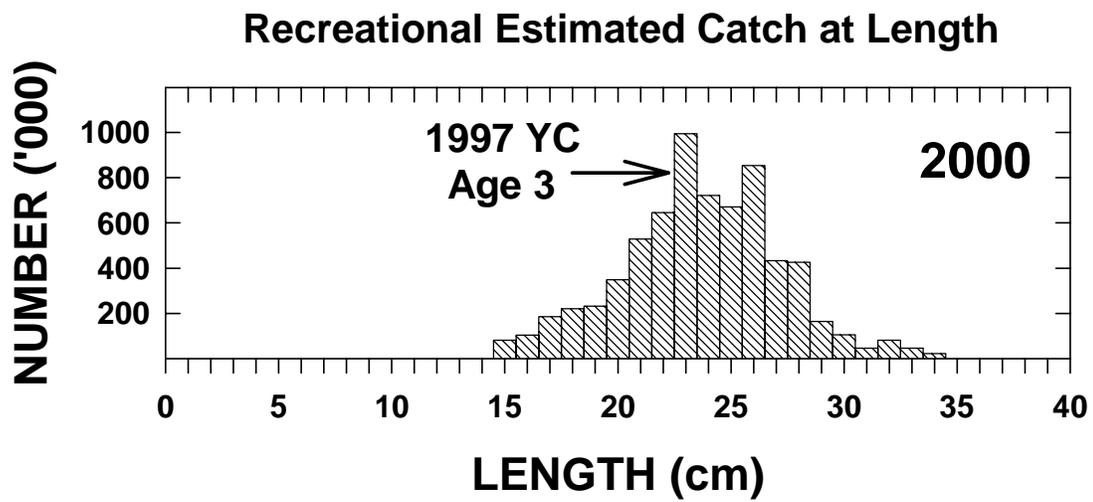


Figure B8. Coastal recreational fishery estimates of scup catch at length (fork length, cm; ME to NC) for 2000.

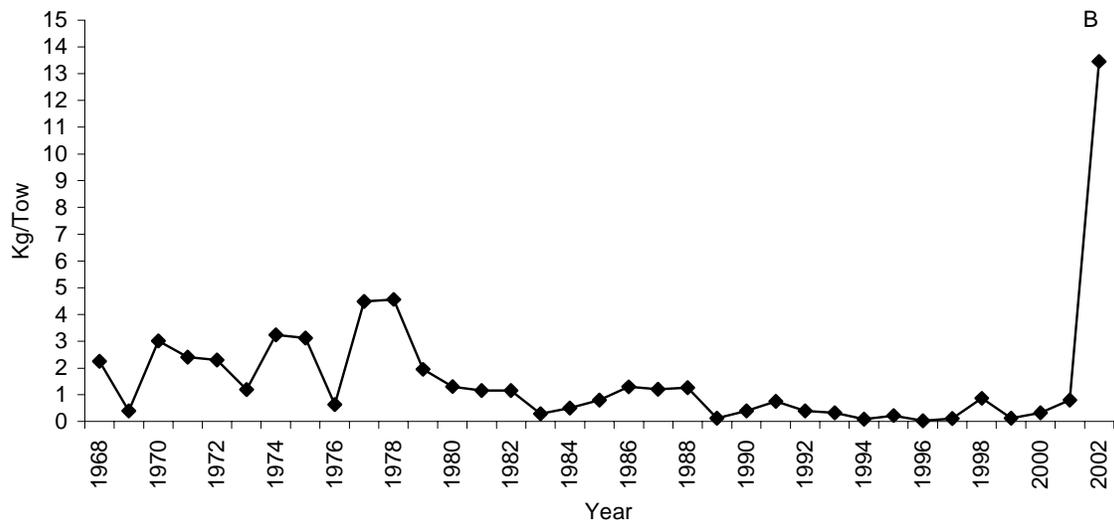
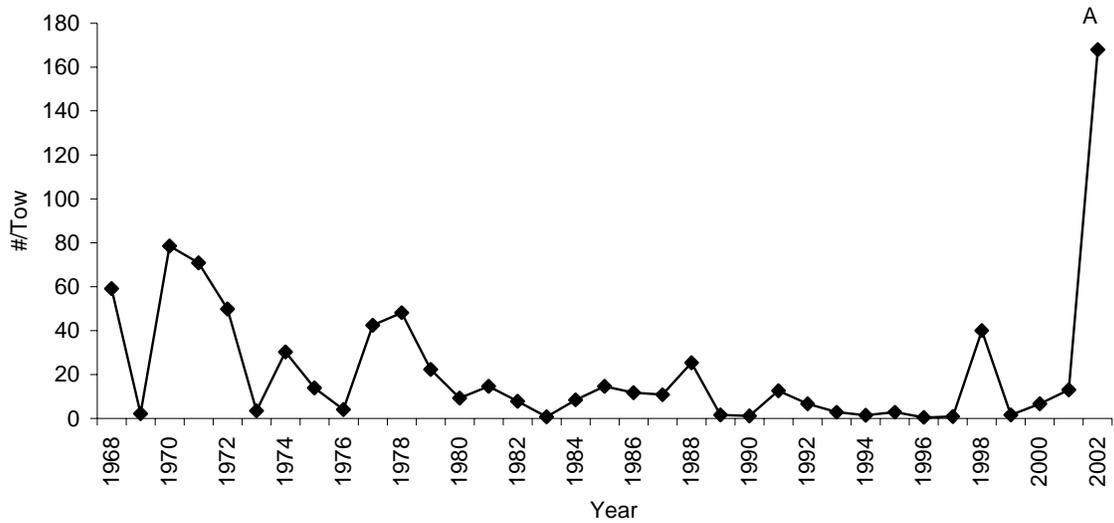


Figure B9. NEFSC spring research vessel survey (1968-2002) indices for scup abundance (A) and biomass (B) based on offshore strata 1-12, 23, 25, and 61-76. **Note that 2002 indices are preliminary.**

NEFSC Fall Survey

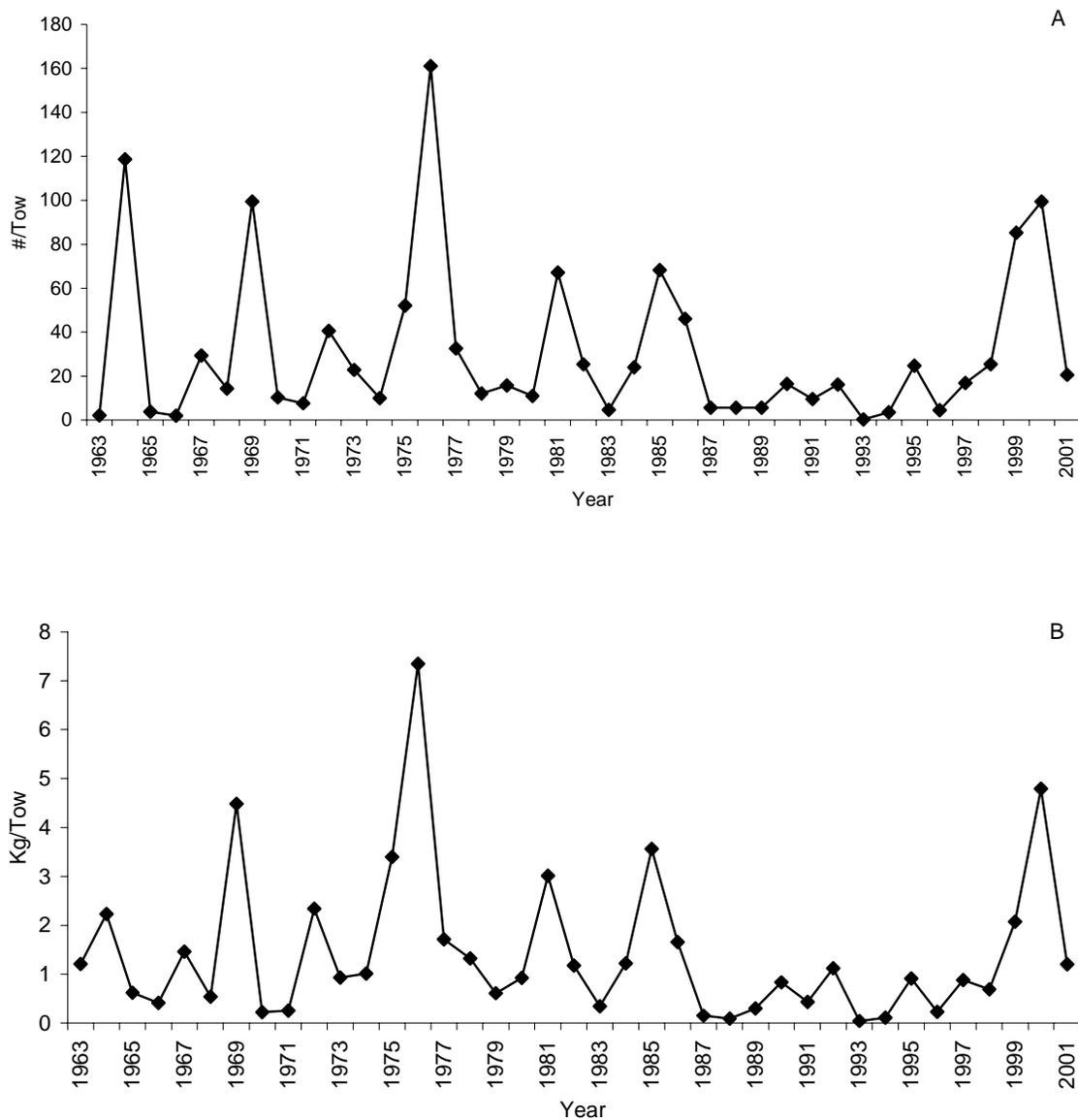


Figure B10. NEFSC fall research vessel survey (1963-2001) indices for scup abundance (A) and biomass (B) based on offshore strata 1-12, 23, 25, and 61-76.

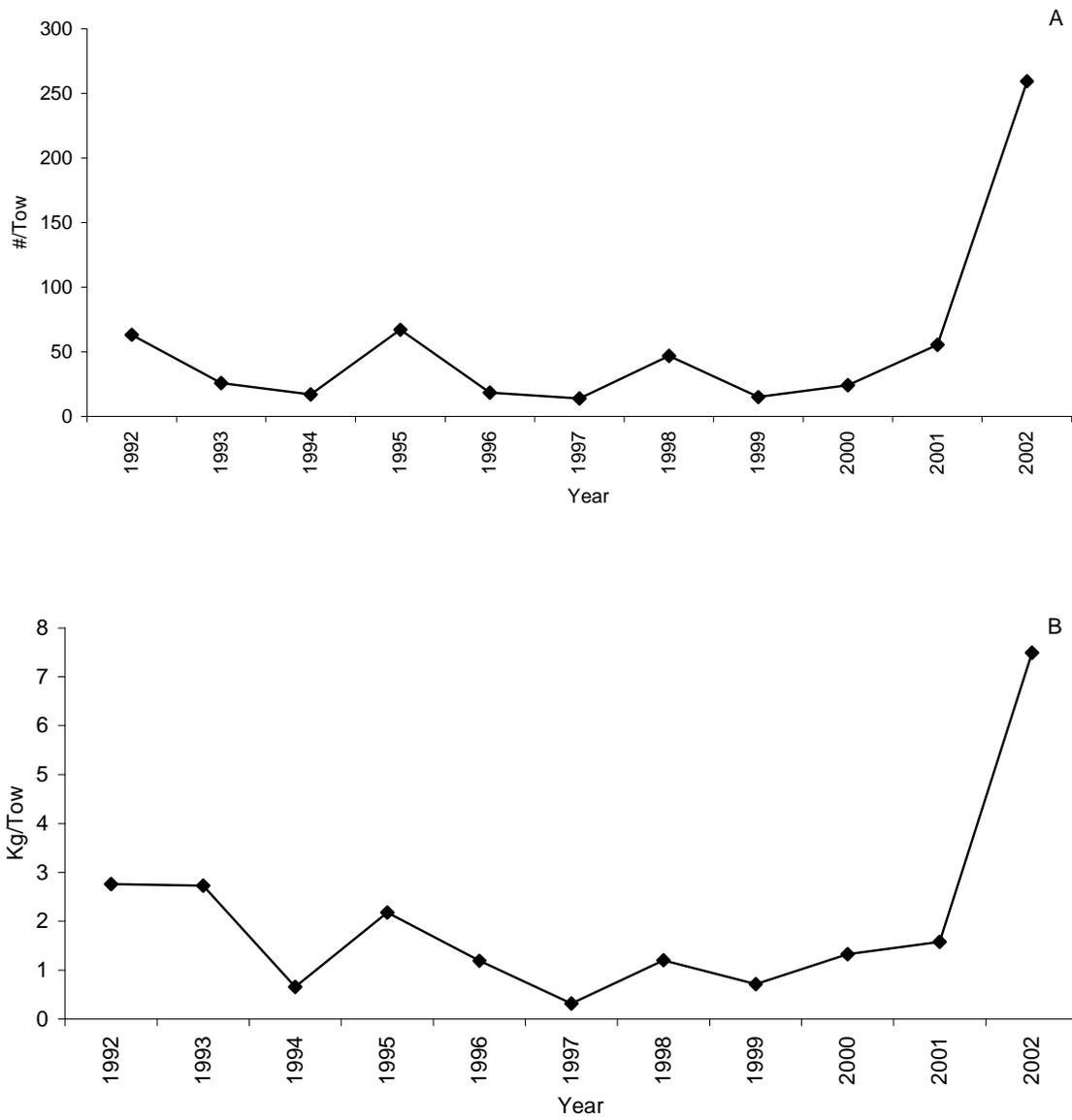


Figure B11. NEFSC winter research vessel survey (1992-2002) indices for scup abundance (A) and biomass (B) based on offshore strata 1-12 and 61-76. **Note that Winter 2002 indices are preliminary.**

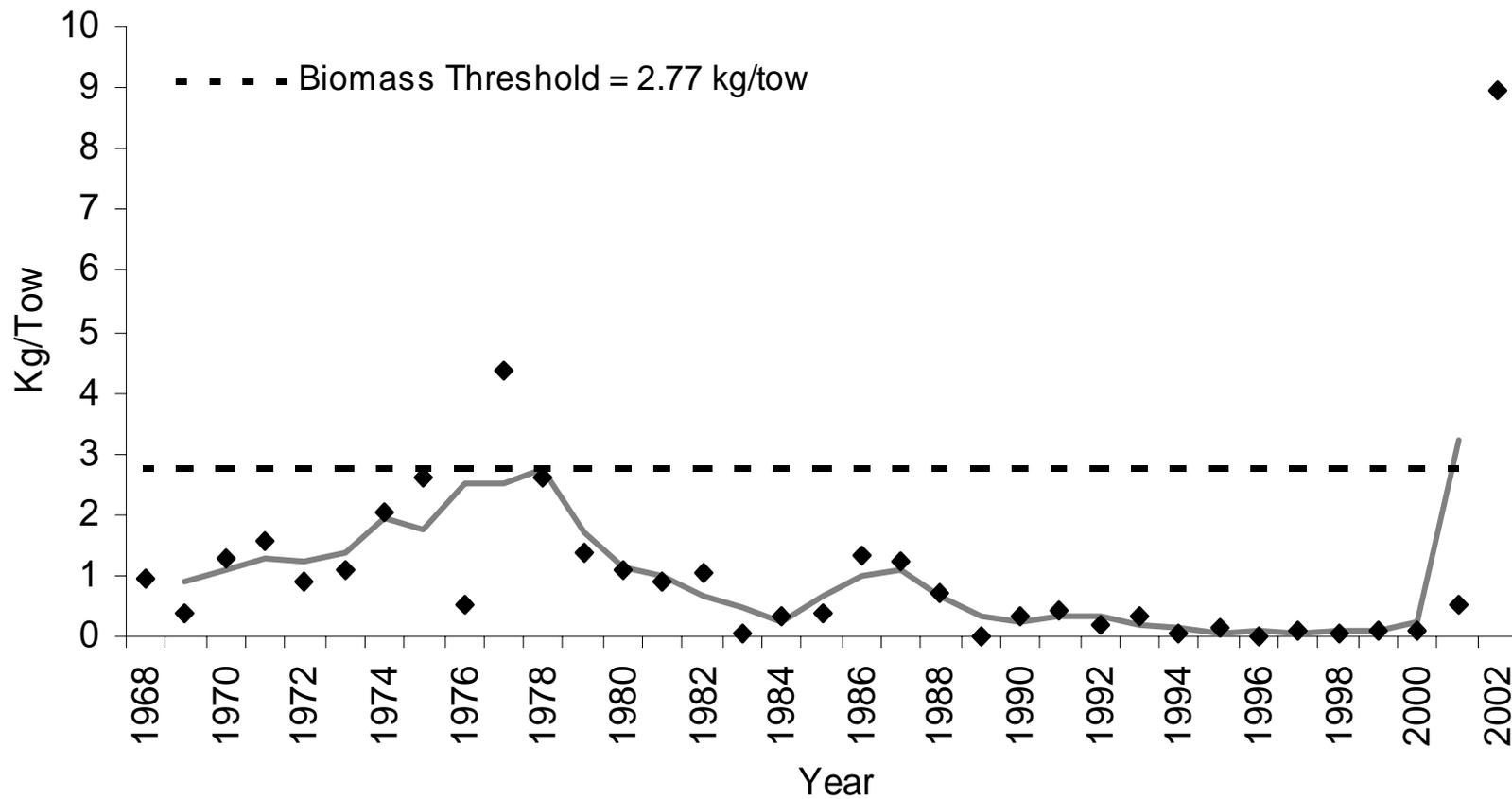


Figure B12. Scup spawning stock biomass per tow (SSB kg/tow) index (points). The solid line represents the 3-year moving average of the SSB. The dotted line represents the biomass threshold adopted for scup in Amendment 12 to the FMP. This threshold is based on the maximum value of the SSB index (2.77 kg/tow, 1977-1979).

MADMF Spring Survey

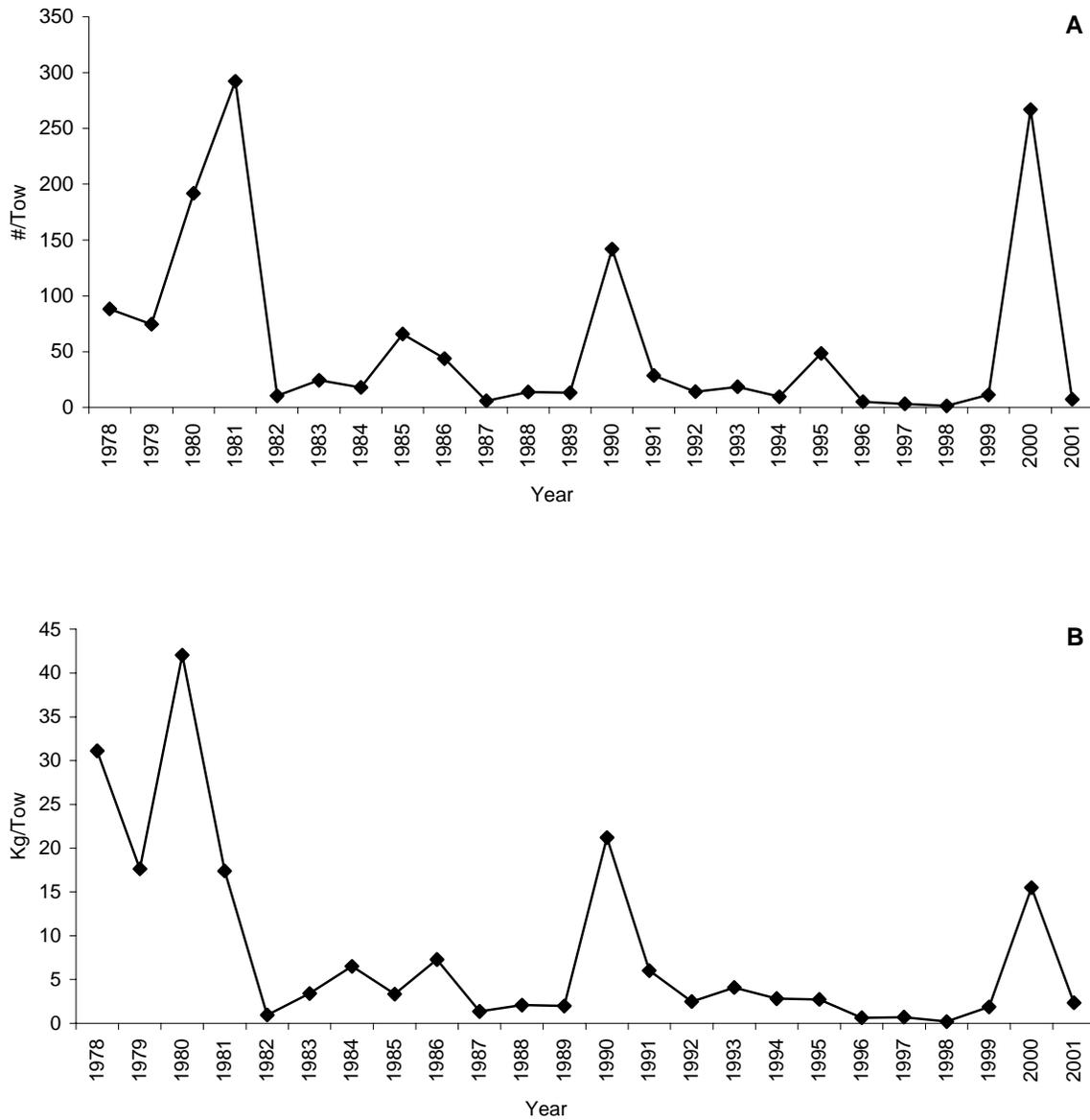


Figure B13. MADMF spring survey (1978-2001) indices for scup abundance (A) and biomass (B) based on survey regions 1, 2, and 3.

MADMF Fall Survey

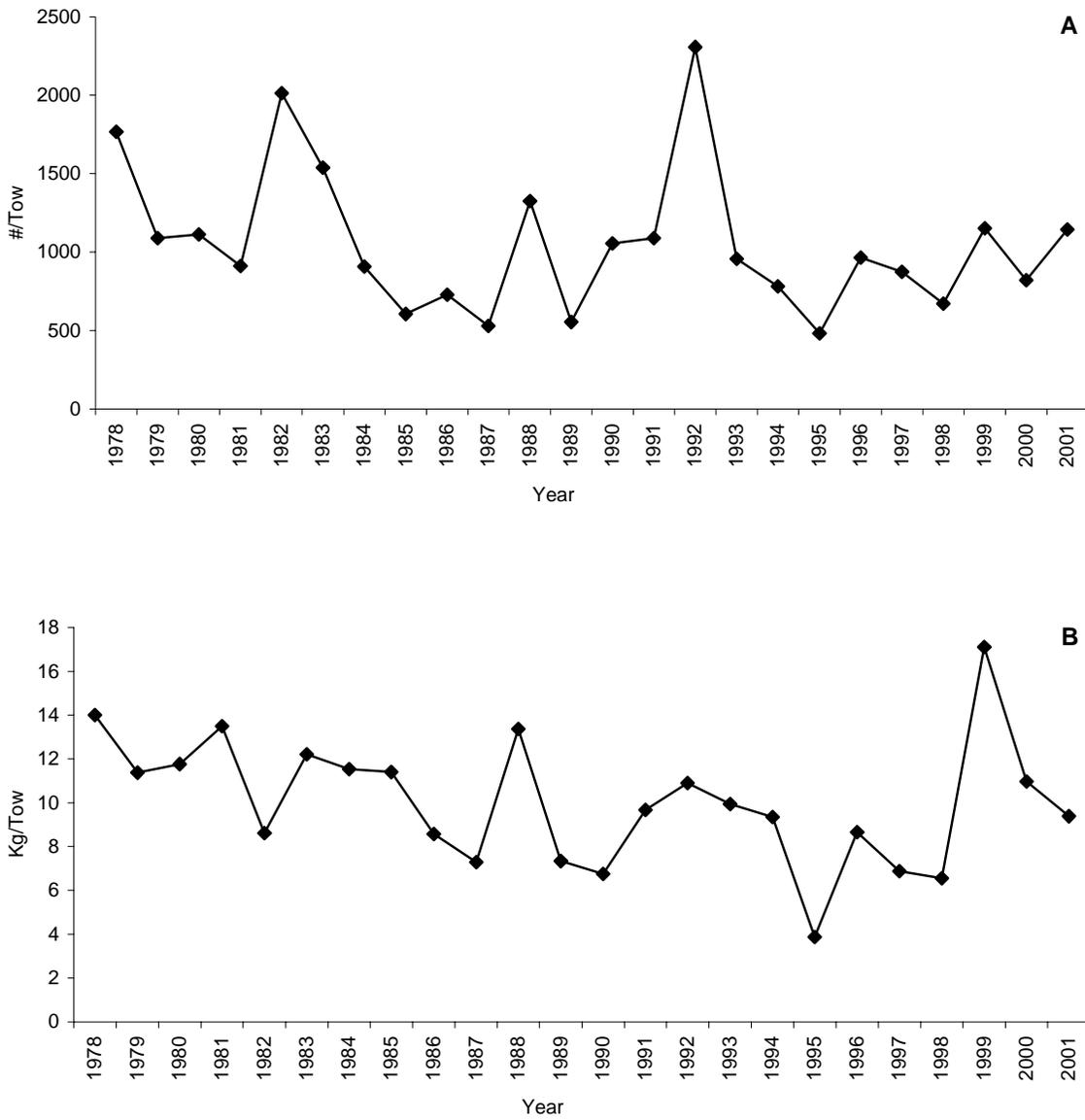


Figure B14. MADMF fall survey (1978-2001) indices for scup abundance (A) and biomass (B) based on all survey regions.

RIDFW Spring Survey

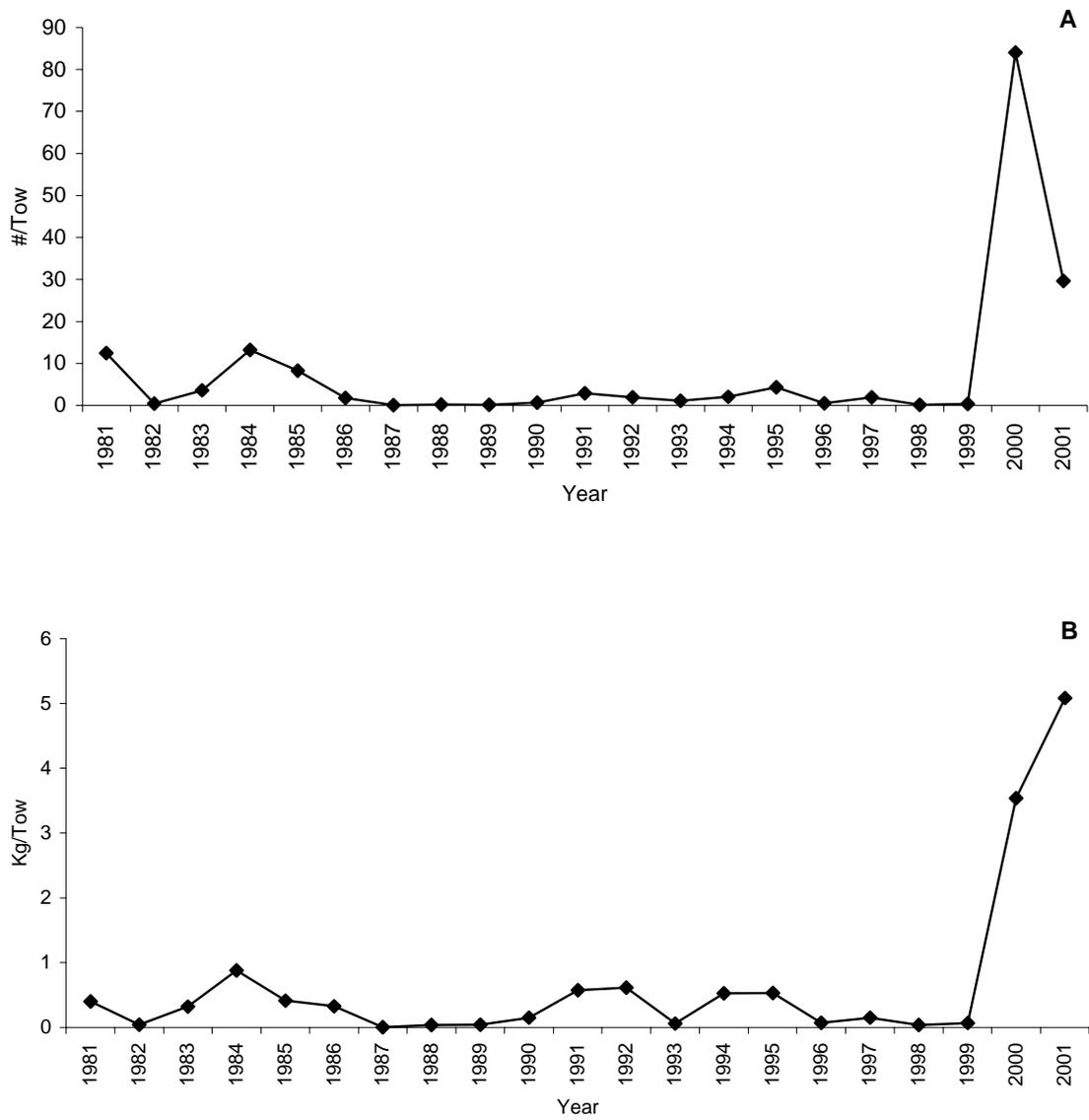


Figure B15. RIDFW spring survey (1981-2001) indices for scup abundance (A) and biomass (B).

RIDFW Fall Survey

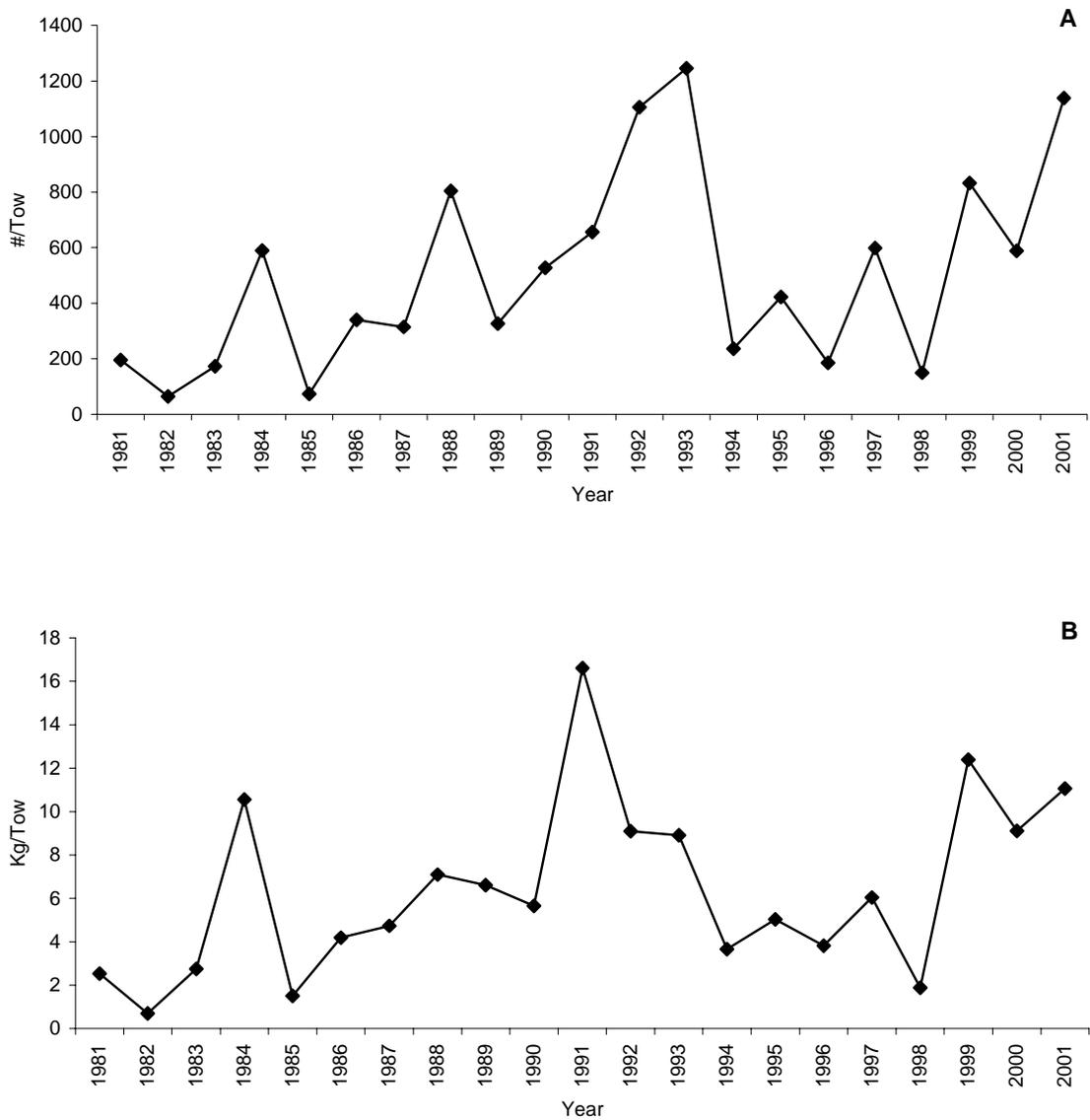


Figure B16. RIDFW fall survey (1981-2001) indices for scup abundance (A) and biomass (B).

CTDEP Spring Survey

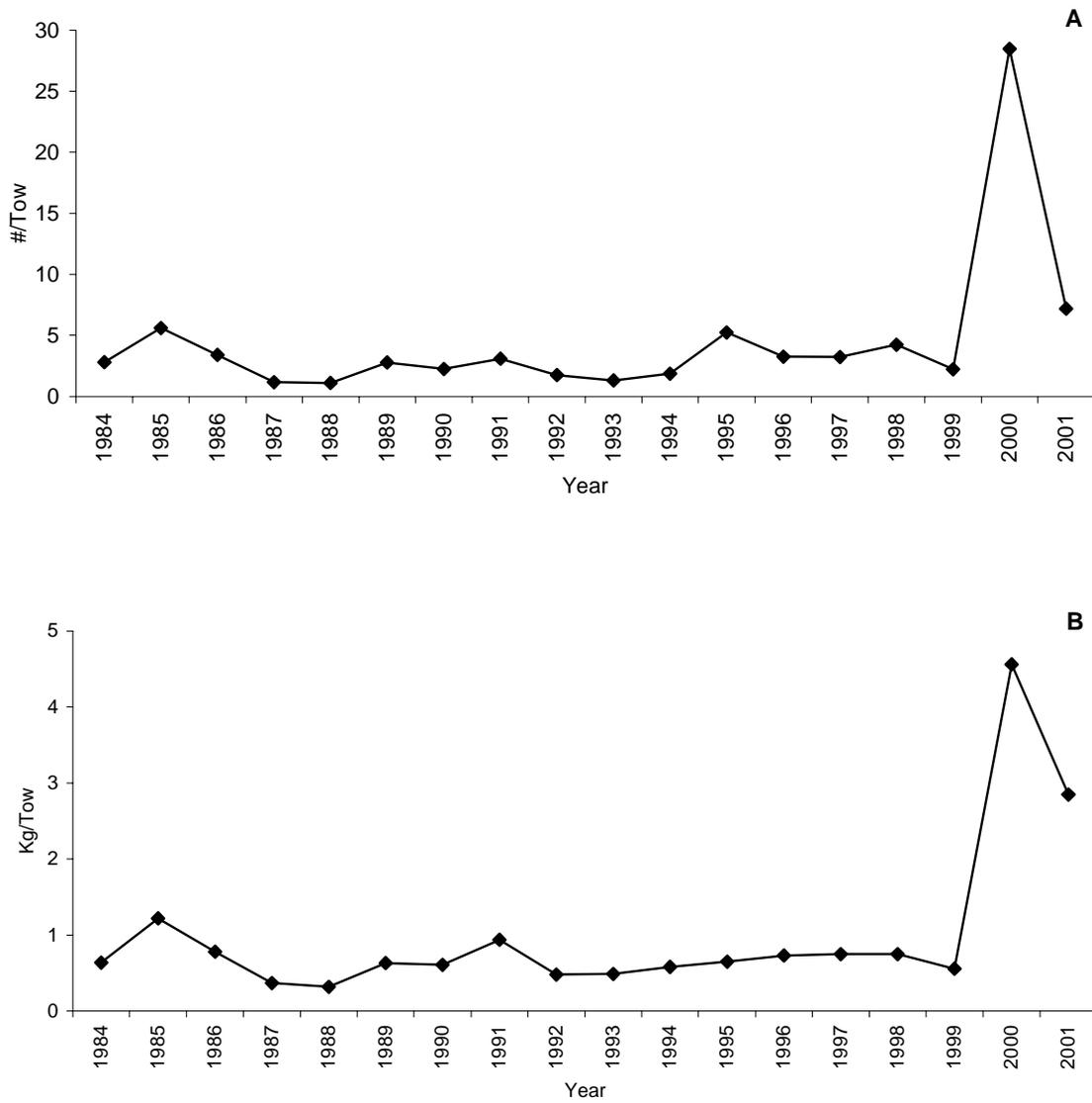


Figure B17. CTDEP spring survey (1984-2001) indices for scup abundance (A) and biomass (B).

CTDEP Fall Survey

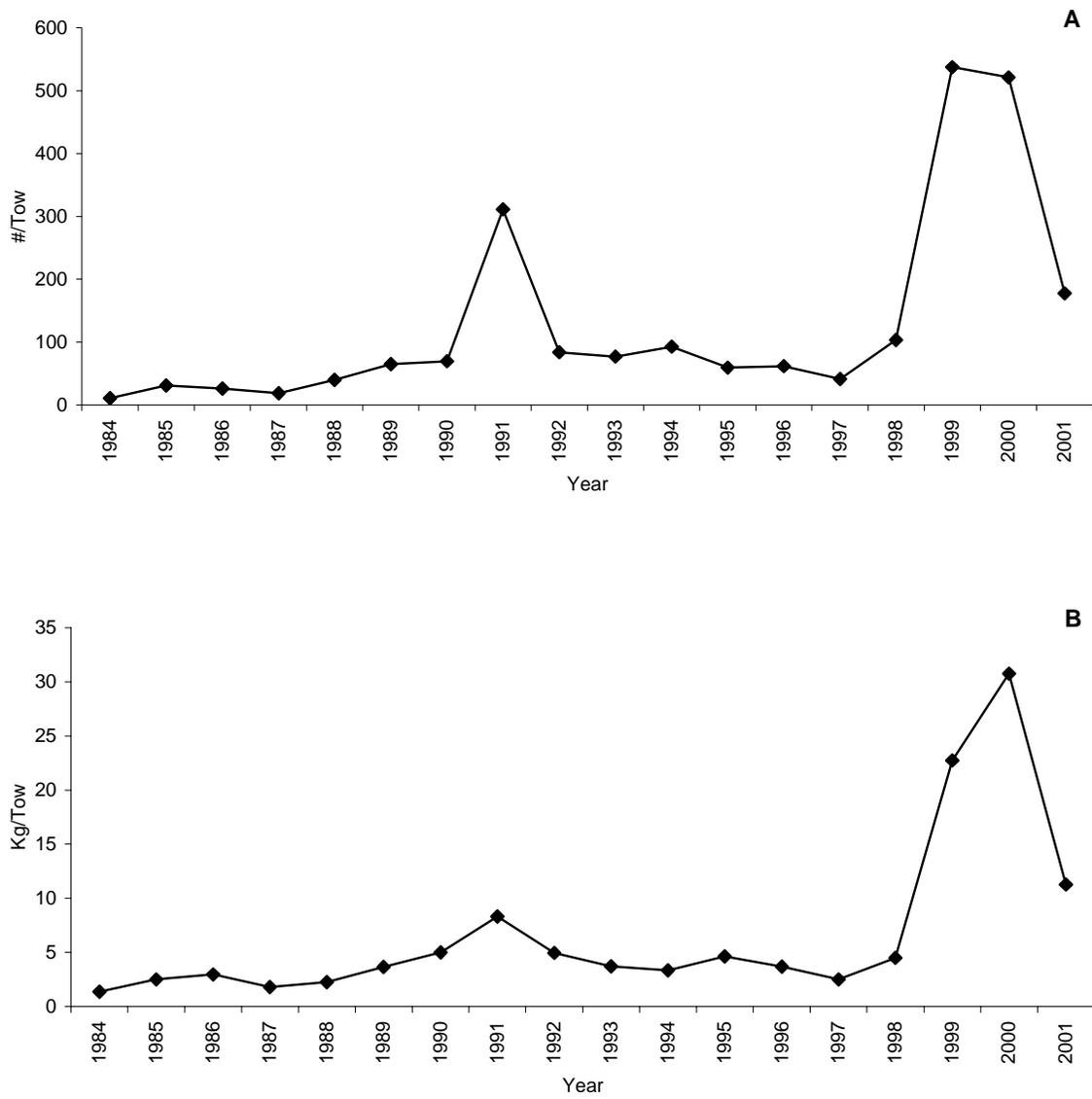


Figure B18. CTDEP fall survey (1984-2001) indices for scup abundance (A) and biomass (B).

NJBMF Annual Survey

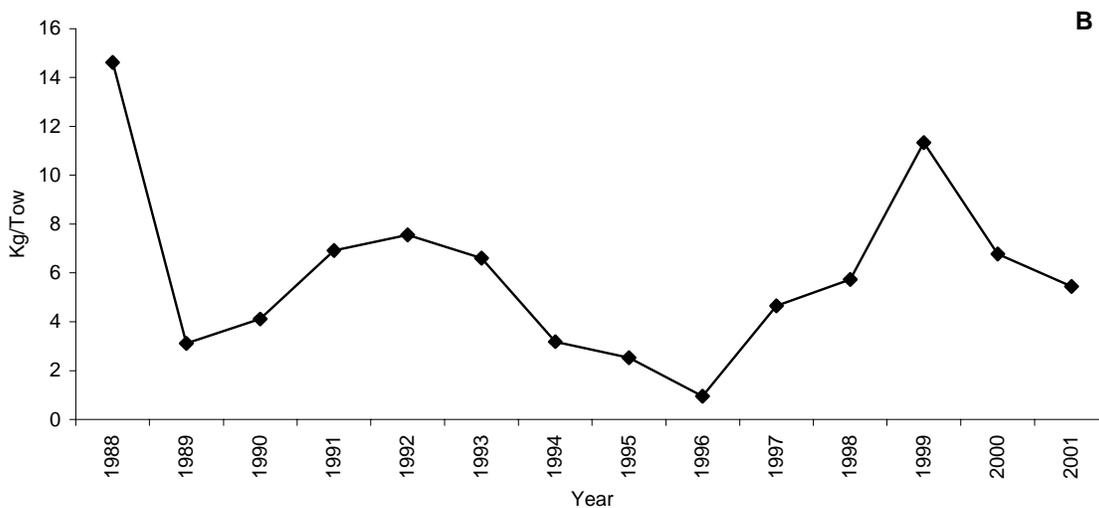
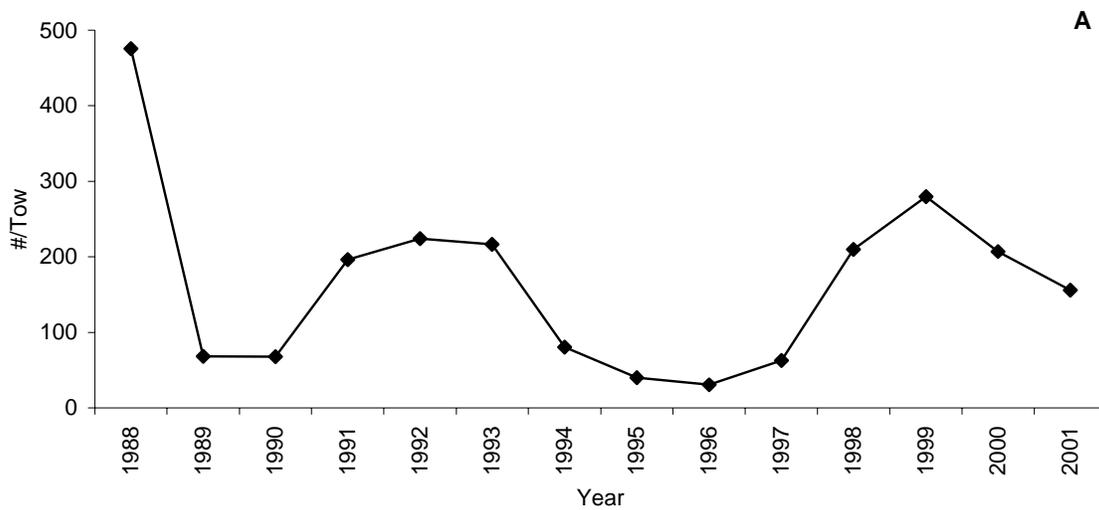


Figure B19. NJBMF survey (1988-2001) indices for scup abundance (A) and biomass (B).

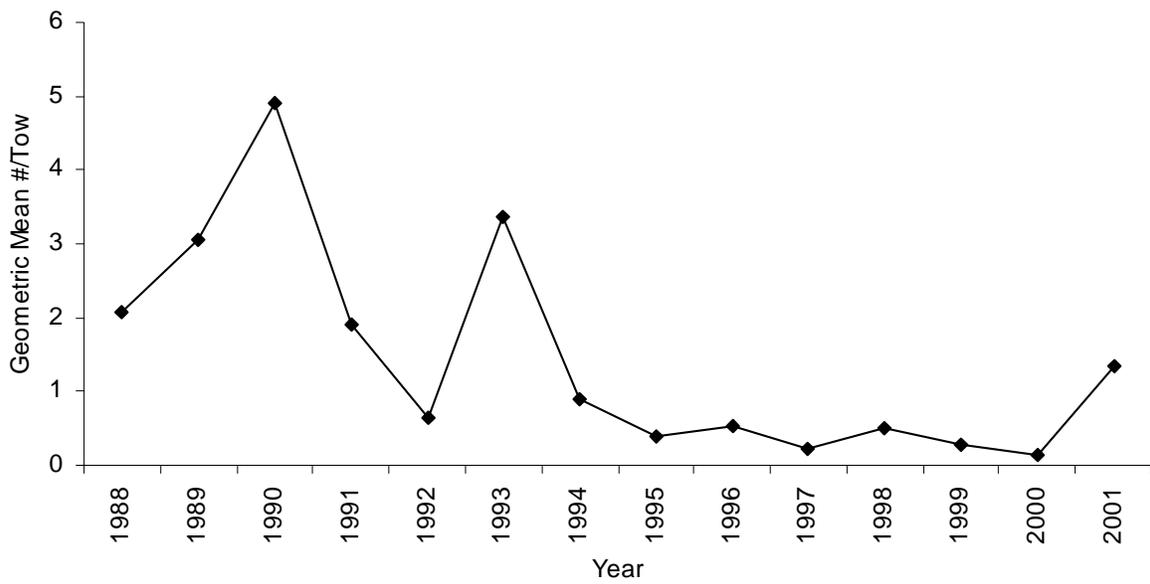


Figure B20. VIMS survey (June – September; 1988-2001) indices for young-of-the-year scup abundance.

NYDEC Survey

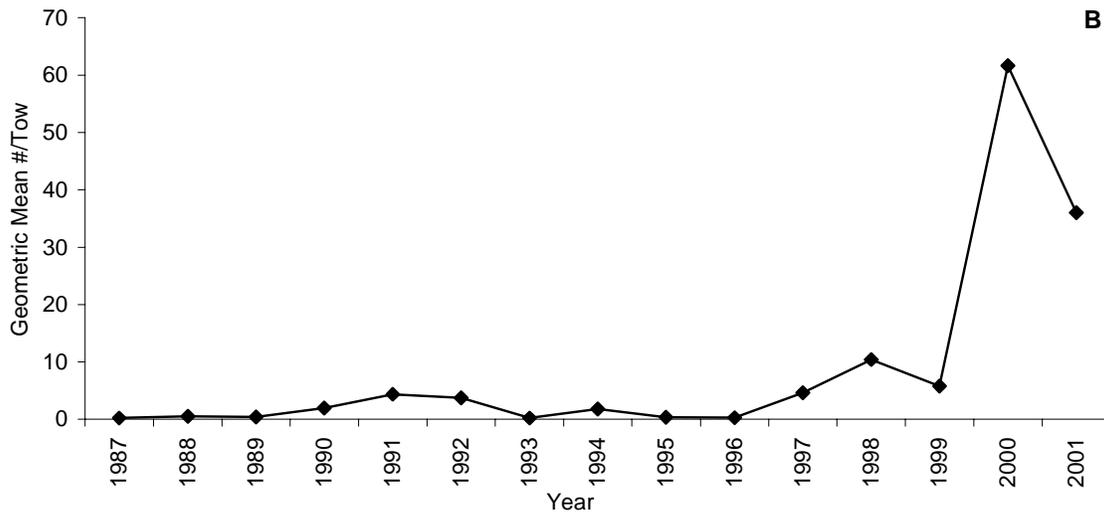
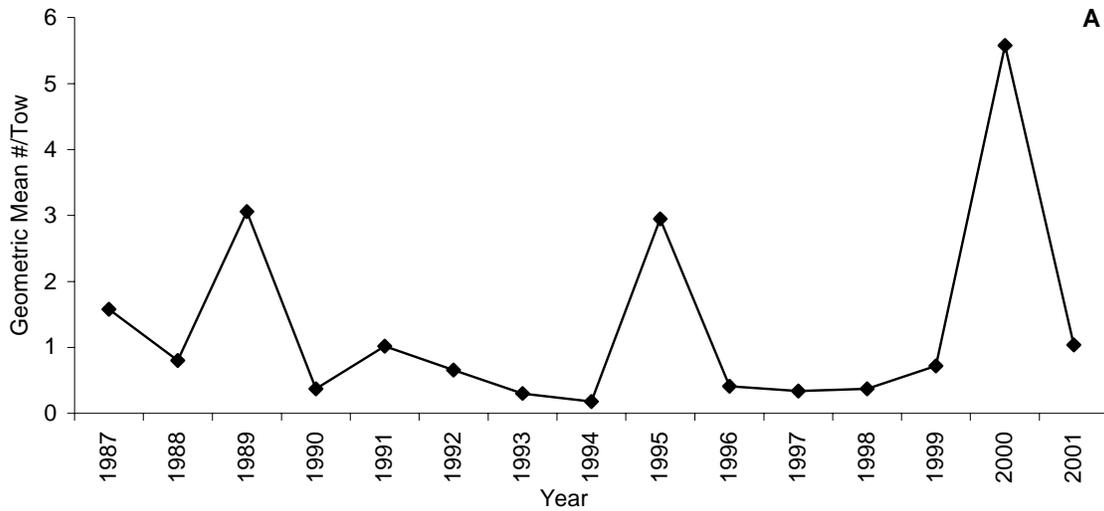


Figure B21. Yearling (A; June-August) and young-of-the-year (B; August-September) scup recruitment indices from the NYDEC survey (1985-2001).

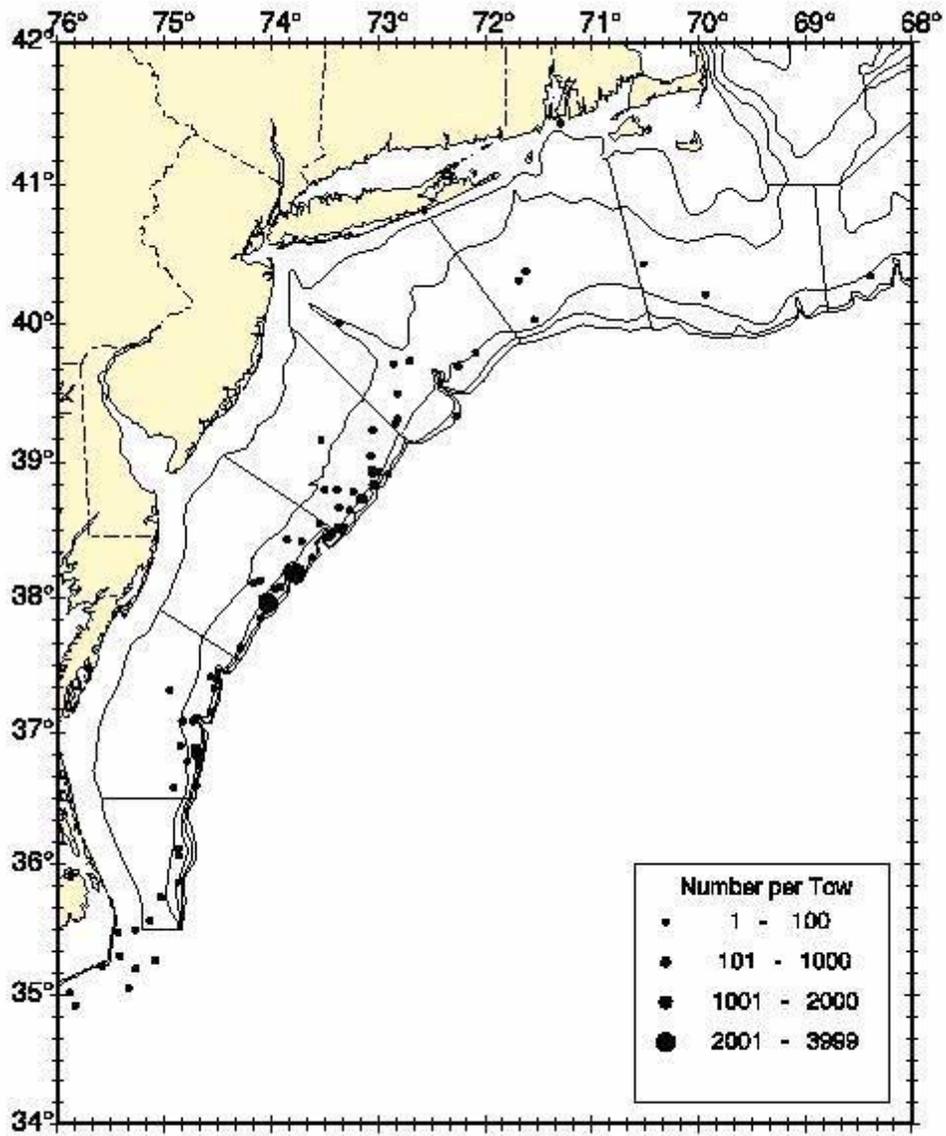


Figure B22. Distribution of scup during NEFSC 1992-1998 spring bottom trawl survey.

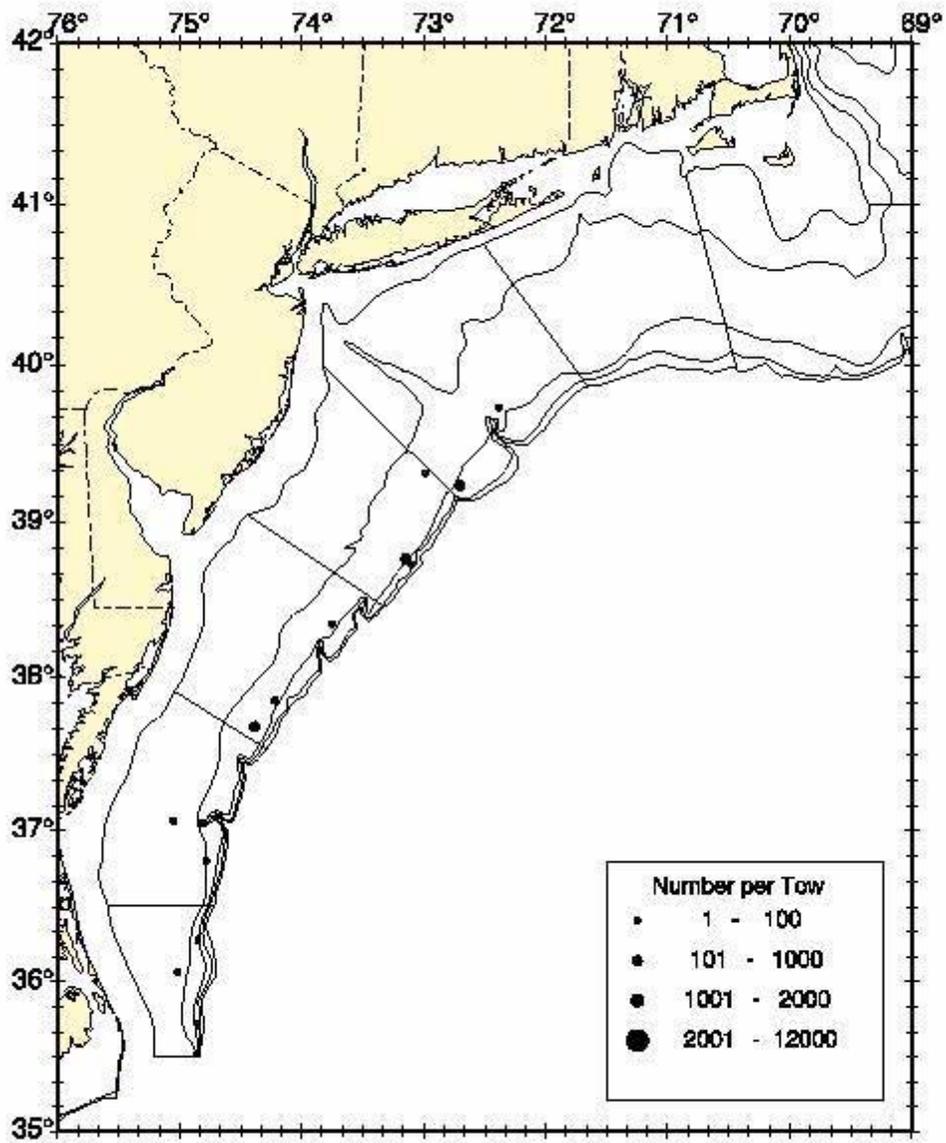


Figure B23. Distribution of scup during NEFSC 2001 spring bottom trawl survey.

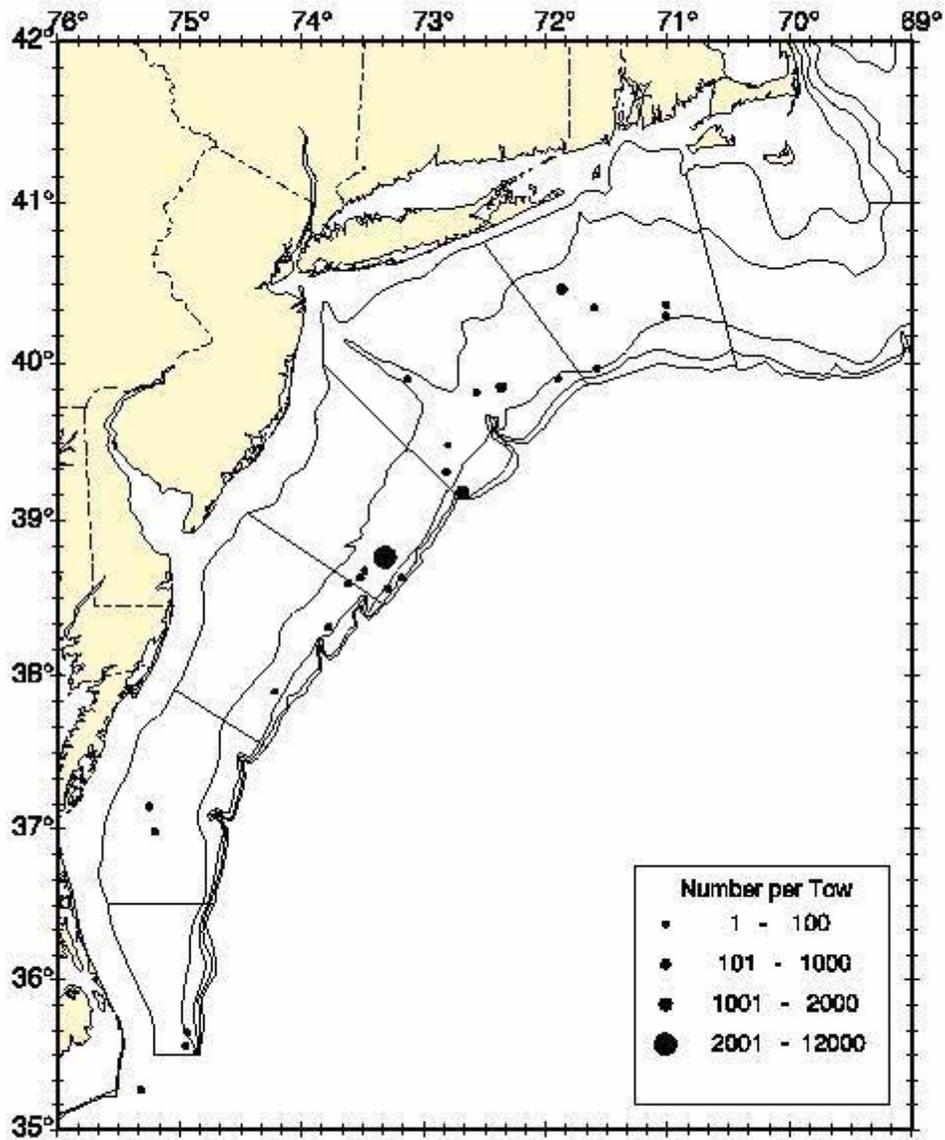


Figure B24. Distribution of scup during NEFSC 2002 spring bottom trawl survey.

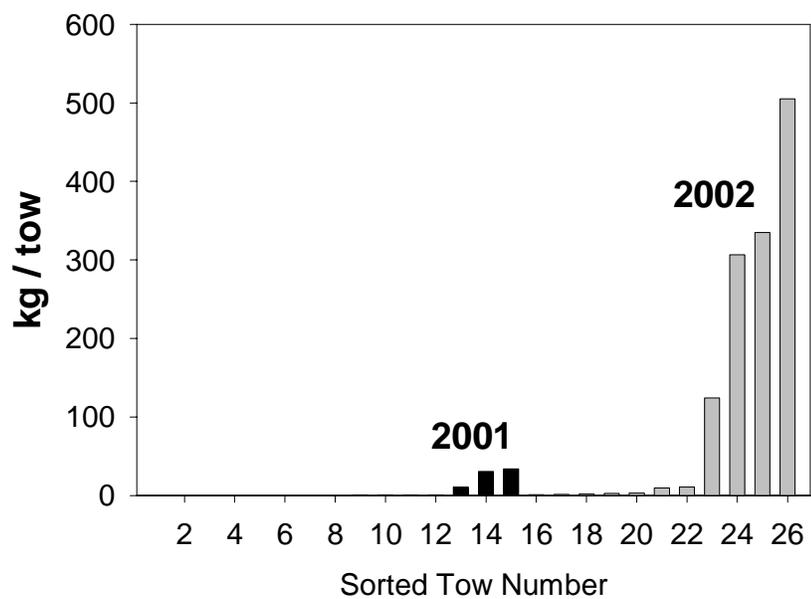


Figure B25. Comparison of the occurrence of positive scup tows and the associated magnitude as observed in the NEFSC 2001 and 2002 spring survey.

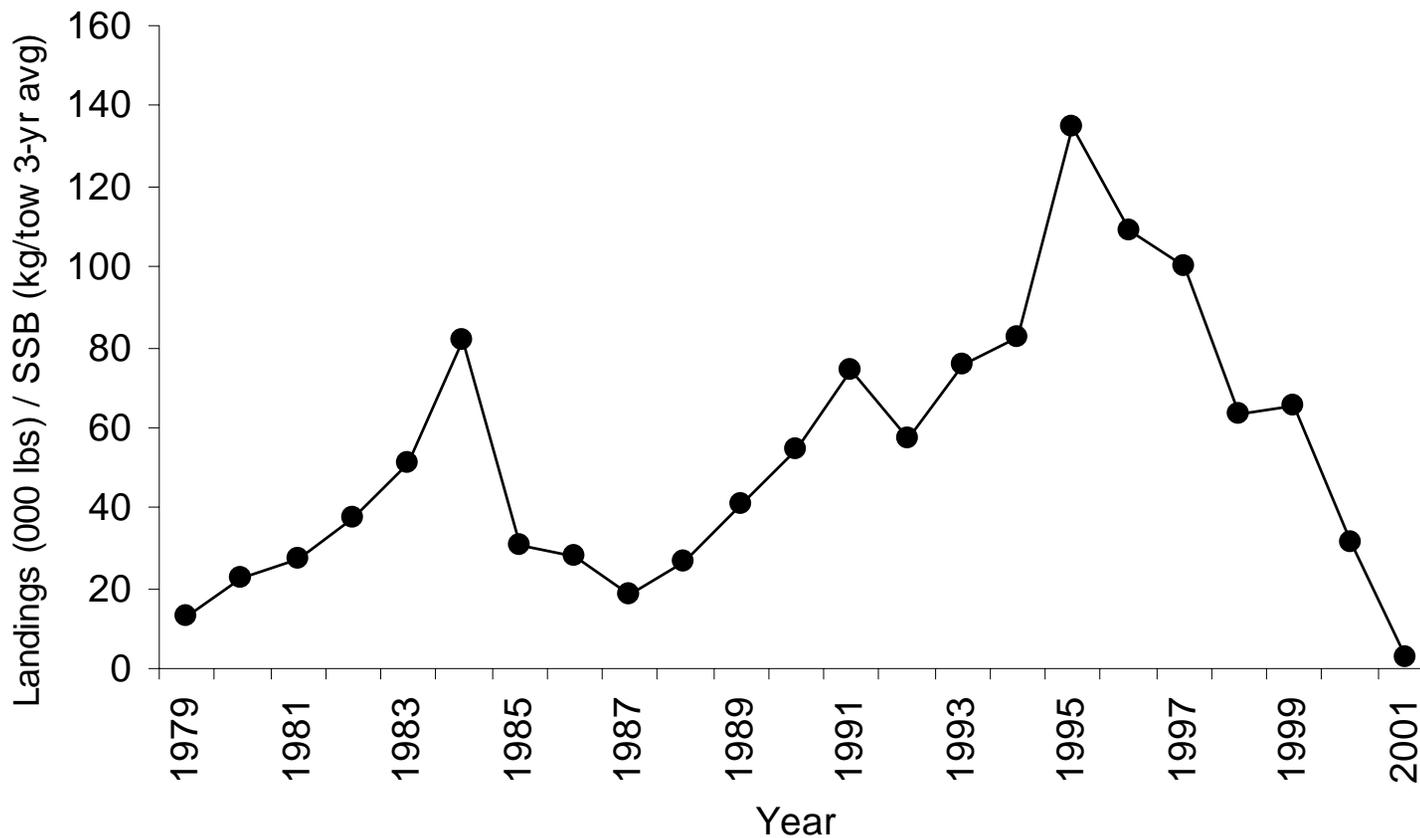


Figure B26. Estimated relative exploitation index based on total landings (1,000's of lbs.) and the NEFSC spring SSB survey (kg/tow; three-year average).

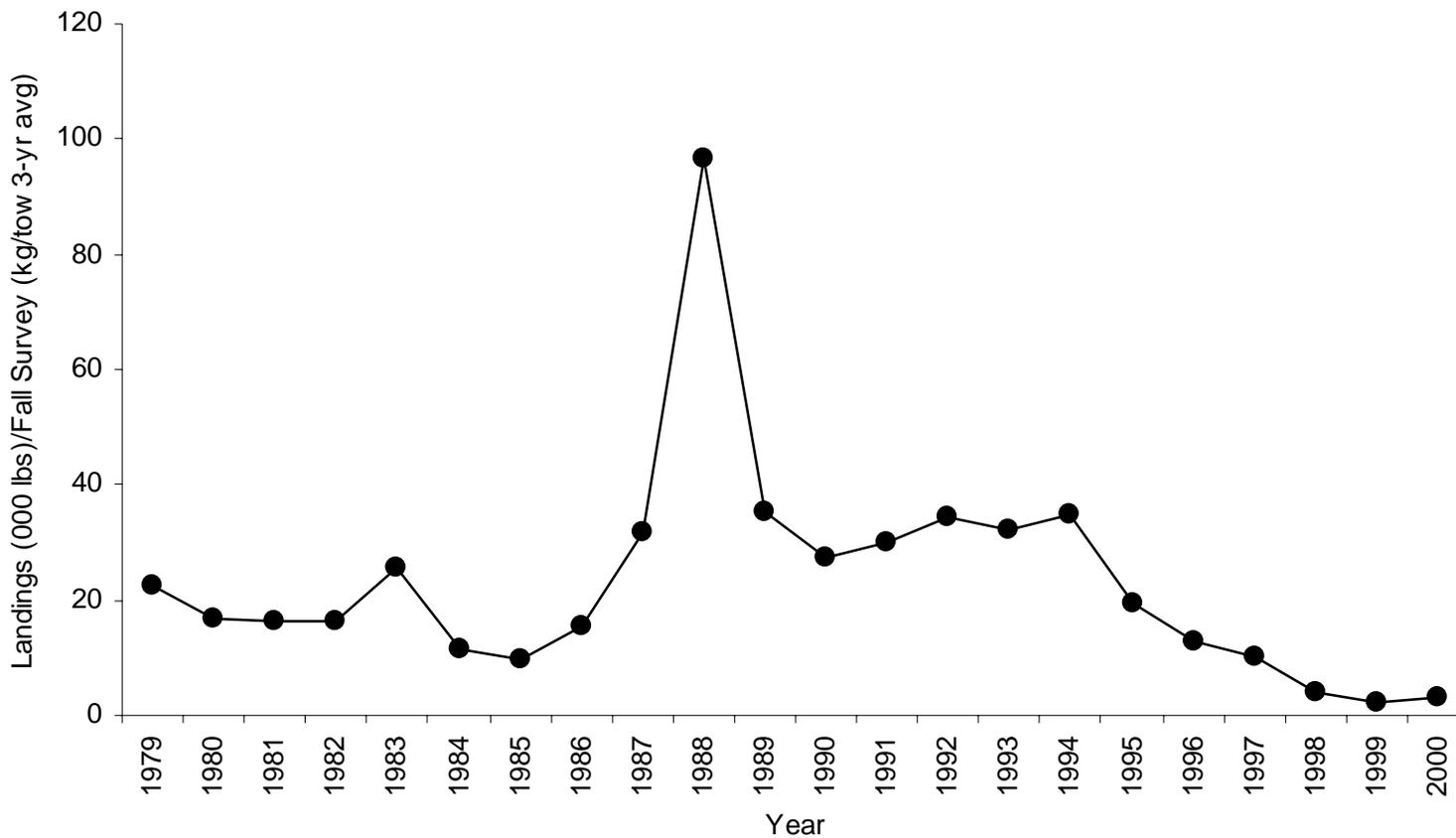


Figure B27. Estimated relative exploitation index based on total landings (1,000's of lbs.) and the NEFSC fall survey (kg/tow; three-year average).

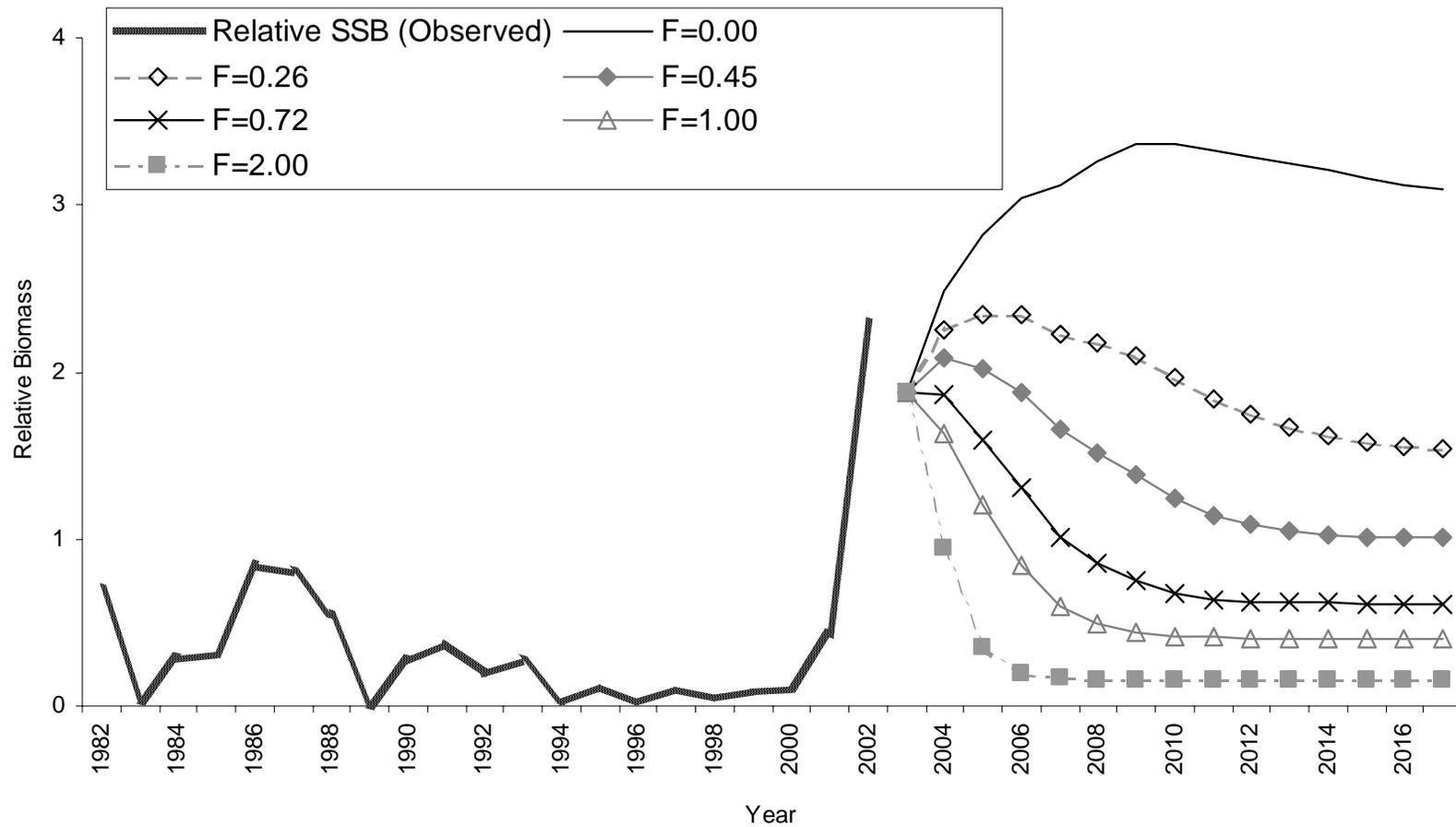


Figure B28. Observed trends in relative SSB ($\ln+1$) and projections of scup relative biomass starting with average of 2000-2002 NEFSC spring survey catch per tow, offshore strata only. Yearly recruitment is assumed equal to the long-term median catch per tow at age 1 (1977-2002). Projections are for F values of 0.00, 0.26, 0.45, 0.72, F=1.00, and F=2.00.